Jules Pieters
Joke Voogt
Natalie Pareja Roblin *Editors*

Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning

Springer Open

Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning

Jules Pieters • Joke Voogt • Natalie Pareja Roblin
Editors

Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning

Springer Open

Editors
Jules Pieters
ELAN Department of Teacher Professional Development
University of Twente
Enschede, The Netherlands

Joke Voogt
Department of Child Development and Education
University of Amsterdam
Amsterdam, The Netherlands

Natalie Pareja Roblin
University of Applied Sciences
Amsterdam, The Netherlands

ISBN 978-3-030-20061-9 ISBN 978-3-030-20062-6 (eBook)
https://doi.org/10.1007/978-3-030-20062-6

This Springer imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Sound curriculum design practices are necessary conditions for a curriculum that is relevant and based on up-to-date knowledge of teaching and learning. There is large agreement on the importance of teachers' active involvement in curriculum design for deep and sustainable educational change. The reasoning behind this is threefold:

- By involving the professionals who engage daily with students, we can come to context-specific innovative curricula that have more relevance and therefore increased the chance for success in schools.
- By having an active role in the design process, the professional development of teachers is enabled and supported. In the process of collaborative curriculum, design teachers learn from one another and from engaging with new content and pedagogies while improving their design competencies.
- By enabling professional development and curriculum design in teacher teams and further increasing chances for sustainable curriculum reform.

While teacher involvement in curriculum design offers multiple advantages, it presents various challenges as well. From a practical perspective, teachers need to understand the curriculum design process and develop design competencies. From a scholarly perspective, there is a need to rethink what curriculum design entails: from a systematic endeavor carried out by professionals to a more intuitive process carried out by (teams of) teachers.

The chapters in this book contribute to an in-depth insight into what it takes to actively involve teachers in the curriculum design process. Specifically, the various chapters examine different aspects of teacher involvement in collaborative curriculum design, with specific attention to its implications for sustainable curriculum innovation and teacher learning. Curriculum innovation is framed in an international context and within broader educational reform issues, paying specific attention to the implications of collaborative curriculum design for sustainable innovation and teacher learning across diverse contexts.

The book is organized into six sections. Section 1 introduces the notion of collaborative curriculum design by discussing its historical and theoretical foundations, as well as various approaches commonly adopted to actively involve teachers in the (co-)design of curriculum materials. Sections 2 and 3 provide examples of how key phases in the curriculum design process (i.e., needs analysis, design and development, implementation) look like across various collaborative curriculum design projects and discuss the challenges associated with supporting and investigating such processes. The chapters in Section 4 report on the impact of collaborative curriculum design on student learning, teacher practices, teacher professional growth, and institutional change. Building on the research evidence about the outcomes of collaborative curriculum design, the chapters in Section 5 focus on sustainability, scaling-up, and curriculum leadership issues, which are key to the continuation and further evolution of curriculum innovations.

The book concludes with two commentaries in Section 6 that critically review key insights from the various chapters and derive general recommendations and perspectives for understanding and supporting collaborative curriculum design projects for teaching and policy practices as well.

We highly appreciate the contributions of the various authors, mainly PhD students and their supervisors. Sadly, one of the authors, Anto Arkato Gendole, passed away during the writing of this book. We would like to dedicate the book to him.

We would also like to thank Emily Fox for her tremendous effort in linguistic and editorial support and Sandra Schele for the final copyediting work. We also owe many thanks to Astrid Noordermeer and her associates at Springer Press for their patience and support during the course of this project. Finally, we would like to thank the DoCenter Foundation for its financial support.

Enschede, The Netherlands Jules Pieters
Amsterdam, The Netherlands Joke Voogt
Amsterdam, The Netherlands Natalie Pareja Roblin

Contents

Contributors

Douglas D. Agyei Department of Mathematics and ICT Education, University of Cape Coast, Cape Coast, Ghana

Edward Akomaning Institute for Educational Planning and Administration, University of Cape Coast, Cape Coast, Ghana

Ghaida Alayyar College of Basic Education – The Public Authority for Applied Education and Training, Adailiyah, Kuwait

Nabeel Albashiry University of Auckland Business School, Auckland, New Zealand

Arkato Gendole Anto School of Graduate Studies, Arba Minch University, Arba Minch, Ethiopia

Marie A. B. Bakah Institute for Educational Planning & Administration, University of Cape Coast, Cape Coast, Ghana

Fer Coenders Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands

Bregje de Vries Free University of Amsterdam, Amsterdam, The Netherlands

Petra Fisser National Institute for Curriculum Development, Enschede, The Netherlands

Chantal Gervedink Nijhuis Royal Dutch Kentalis, Sint-Michielsgestel, The Netherlands

Adam Handelzalts Teacher Education Department, Free University, Amsterdam, The Netherlands

Tjark Huizinga Department of Innovative and Effective Education, Saxion University of Applied Sciences, Enschede, The Netherlands

Ayoub Kafyulilo Department of Psychology and Curriculum Studies, Dar es Salaam University College of Education, Dar es Salaam, Tanzania

Susan McKenney Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands

Nienke Nieveen ELAN Department of Teacher Development, University of Twente, Enschede, The Netherlands

Kassimu A. Nihuka Institute of Adult Education, Dar es Salaam, Tanzania

Natalie Pareja Roblin University of Applied Sciences, Amsterdam, The Netherlands

William R. Penuel School of Education and Institute of Cognitive Science, University of Colorado Boulder, Boulder, CO, USA

Jules Pieters ELAN Department of Teacher Professional Development, University of Twente, Enschede, The Netherlands

Jan Van den Akker University of Twente, Enschede, The Netherlands

Joke Voogt Department of Child Development and Education, University of Amsterdam, Amsterdam, The Netherlands

Amber Walraven Radboud Teachers Academy, Radboud University, Nijmegen, The Netherlands

Hanna Westbroek Free University of Amsterdam, Amsterdam, The Netherlands

Part I
Setting the Scene for Curriculum Innovation: Editorial Introduction

Curriculum Innovation: A Function of Collaborative Curriculum Design and Teacher's Professional Development

This first section of the book sets the scene through conceptualizing curriculum and curriculum design. Starting with the well-known definition of curriculum as 'a plan for learning', this section addresses various related concepts and discusses the development of the field. In particular, three issues are discussed which are key to understanding curriculum and its function in the educational system: (1) curriculum change and the involvement of teachers as main stakeholders; (2) learning not only by students but also by teachers through their engagement in curriculum design; and (3) the sustainability of a curriculum innovation. The chapters in this section pay attention to the active role of teachers in designing the curriculum and its impact on teacher learning, both in a collaborative context. In this book various chapters will discuss curriculum innovation in developing countries. Therefore, in this first section, the educational context of these countries is discussed. This section also introduces the process of designing curricula and its pivotal components: needs analysis and assessment; design, development and implementation; its outcomes and relevance for students, teachers and teaching practices; and the long-term effects through continuation, sustainability and up-scaling. Throughout the different sections of this book various methods are used to study collaborative design in teams across the different components of the curriculum design process: quantitative, qualitative, and mixed methods.

The first chapter by Joke Voogt, Jules Pieters and Natalie Pareja Roblin on the historical and theoretical foundations of collaborative curriculum design in teacher teams serves as general introduction to the book. It discusses the role of teachers in curriculum design and innovation from a historical perspective, and examines its theoretical foundations. History shows that the intentions and ambitions of many curriculum innovations failed because the complexity of the design and implementation processes was often overlooked. Lack of teacher involvement in curriculum design processes is seen as an important cause for these disappointing outcomes.

Several scholars have therefore called for more active involvement of (teams of) teachers in curriculum design processes. The first part of this chapter discusses the role of teachers in curriculum design, and how views about their involvement have evolved over time from reactive to more proactive involvement. Next, the authors examine how the products of curriculum design, curriculum materials, may contribute to teacher learning and curriculum enactment. Finally, these two perspectives are brought together using insights from sociocultural theory to conceptualize the key principles underlying collaborative curriculum design in teacher teams.

The chapter by Natalie Pareja Roblin and Susan McKenney on classic design of curriculum innovations examines the Research, Development and Diffusion (RD&D) model, which for many years has dominated the ways in which research is used to inform the design of (large scale) curriculum innovations. Specifically, the study reported aimed to ascertain how research and practice relationships are shaped in RD&D projects, with a particular focus on teachers' involvement and roles in the curriculum design process. From the larger literature concerned with the design of research-based curriculum innovations, nine projects featuring key characteristics of the RD&D model were selected and analyzed. Findings confirmed that the RD&D model lives up to its potential to promote active utilization of research to inform the design of curriculum innovations. All projects analyzed reported the use of scientific research literature and findings from systematic evaluation studies as main sources of knowledge informing curriculum design. Furthermore, and in strong contrast to the criticisms to the model, results indicate increased attention to the context and active involvement of teachers in the design process. Overall, this study inspires novel ways of thinking about the core RD&D assumptions, and provides specific examples of how to actively involve teachers in fruitful research, development and diffusion processes.

Teachers increasingly act as co-designers of curriculum materials, because this process can positively affect their professional development while also yielding resources that are relevant and useful for teaching practice. The chapter by Hanna Westbroek, Bregje de Vries, Adam Handelzalts, Amber Walraven and Susan McKenney on teachers as co-designers explores evidence related to the claim that involving teachers in collaborative design is worth the effort. Two data sources were used: papers from scientific journals, reflecting the researcher's perspective, and from professional journals, providing a colloquial corpus reflecting the teacher's perspective. The authors conclude that the colloquial corpus justifies the claim that co-design is gaining momentum, but that the scientific corpus is still limited. Common patterns identified across the professional articles complement the patterns identified in the scientific corpus. At the same time, two distinct pictures of design teams emerge, one from each of the two corpora, with different process characteristics as well as reported effects.

The chapter by Adam Handelzalts, Nienke Nieveen and Jan Van den Akker on teacher design teams as a school-based curriculum innovation reports and reflects upon an early study on the potential of teacher design teams as a means for school-wide curriculum development. Here, teacher collaboration is seen as essential to bridge the gap between the work of individual teachers (within their own subjects and classrooms) and school-wide curriculum renewal aspirations. The chapter provides the rationale behind teacher design teams together with experiences and findings from a school site where such teacher design teams have been active in the redesign of their local curriculum. The chapter ends with discussion of several conclusions and recommendations for schools and teachers that aim to pursue such a teacher design team scenario.

To assure high quality education in developing countries, curriculum development endeavours are often initiated as part of international cooperation projects. Culture affects the educational context of the countries involved and the way in which curriculum developers from different countries are used to work and behave. Therefore, the influences of culture on curriculum development cannot be neglected. The final chapter of this section by Chantal Gervedink Nijhuis aims to shed light on cultural factors influencing curriculum development processes. The study took place in the context of international cooperation programme that involved project partners from Ghana and The Netherlands. Specifically, the project studied concerned the development and implementation of a professional development programme for Heads of Department of polytechnics in Ghana. In the chapter, a conceptual framework is first developed and cultural challenges affecting the development, implementation and sustainability of the professional development programme are investigated. Next, the findings are compared with similar international cooperation projects to substantiate the outcomes. As this study reinforced and strengthened the importance of accounting for culture, this chapter also provides guidelines and recommendations for culturally sensitive curriculum development in the context of international cooperation.

Chapter 1
Collaborative Curriculum Design in Teacher Teams: Foundations

Joke Voogt, Jules Pieters, and Natalie Pareja Roblin

Introduction

A curriculum is a plan for learning (Taba, 1962) in which goals and content for teaching and learning are organized in a particular way (Walker, 2003). Such a plan for learning is often reflected in concrete curriculum materials. What goals and content are worth teaching, because of their relevance for students and society, is a core curriculum question (Tyler, 1949). Answers to this question include views on the heritage of the past and the aspirations for the future (Williamson, 2013). Discourse on the substantive perspective of curriculum is thus an important part of curriculum as a field of study, in particular in our present times of rapid changes in the labour market and the rapid production of knowledge. However, according to Stenhouse (1975), what is essential for curriculum study is not only discourse about what needs to be taught and learned, but also (and primarily) developing an understanding of the relationship between curriculum as intention and as reality. This implies that we need to understand the processes involved in curriculum design and implementation. The focus of this chapter is on these processes. Specifically, we are

J. Voogt (✉)
Department of Child Development and Education, University of Amsterdam, Amsterdam, The Netherlands
e-mail: j.m.voogt@uva.nl

J. Pieters
ELAN Department of Teacher Professional Development, University of Twente, Enschede, The Netherlands
e-mail: j.m.pieters@utwente.nl

N. Pareja Roblin
University of Applied Sciences, Amsterdam, The Netherlands
e-mail: n.n.pareja.roblin@hva.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_1

particularly interested in the ways teachers are involved in the processes of designing and implementing curricula.

As many recent curriculum innovations result in disappointing outcomes (e.g., Alexander & Flutter, 2009; Haug, 2003; Niederhauser et al., 2018), Stenhouse's argument is still relevant today. There is a need to better understanding how to realize sustainable implementation of curriculum innovations. Curriculum design, as an important subdomain of curriculum study, aims at bridging the gap between curriculum intentions and implementation. In other words, it is the study of how to make curriculum innovations work in practice. Curriculum design is an iterative process, in which knowledge about design procedures and knowledge about indicators of curriculum quality is intertwined with socio-political interests and the realities of many different stakeholders, teachers in particular. Scholars increasingly agree that the process of curriculum design needs to be understood as a process of systemic change (Fullan, 2008; Van den Akker, 2003). From this perspective curriculum is far more than a simple plan for learning. Curriculum is a social cultural practice, which meaning progresses through the active involvement of teachers and other stakeholders in design - and action research.

This book starts from the premise that teachers are core stakeholders in curriculum innovation and in the complex process of curriculum design because, as Fullan (1991) has stated, in the end, 'educational change depends on what teachers do and think – it's as simple and complex as that' (p. 117). We argue that teachers' active involvement in curriculum design is a promising avenue for bridging the gap between curriculum intentions and reality, because it offers opportunities for teacher learning and develops a sense of ownership in teachers for the curriculum innovation at stake (Penuel, Fishman, Yamaguchi, & Gallagher 2007; Voogt et al., 2011,). Therefore, curriculum design that contributes to the effective and sustainable implementation of curriculum innovations is related to and closely dependent on teachers' professional learning.

In this first chapter we set the stage for the research presented in this book. We consider curriculum design and teacher learning as interdependent. Thus, the interaction between teachers and curriculum is central in the way curriculum is understood throughout the studies presented in the book. In the subsequent section we discuss how views on the *curriculum design process* have evolved, and consider the roles for teachers in these different views on curriculum design. Next, the focus is on the relationship between teachers and the main *outcome of curriculum design*, the curriculum materials. In the final section of this chapter, these two perspectives (i.e., curriculum design *processes* and *outcomes*) are brought together. Because effective teacher professional development is *situated and collaborative in nature* (e.g., Penuel et al. 2007; Putnam & Borko, 2000; Voogt et al., 2015), we elaborate on the theoretical conceptualizations underlying collaborative curriculum design in teacher teams.

Roles for Teachers in Approaches to Curriculum Design

Based on an extensive study of the practice of educational design, Visscher-Voerman and Gustafson (2004) distinguished four paradigms that guide curriculum design processes: the instrumental paradigm, the communicative paradigm, the artistic paradigm, and the pragmatic paradigm. The first three of these paradigms are grounded in theoretical views about curriculum and curriculum design and the fourth, the pragmatic paradigm, emerged from the field of software engineering. While analysis, design, development, implementation and evaluation (ADDIE) are all essential elements of the design process across these four paradigms, their specific sequence as well as the types of design activities involved differ (Visscher-Voerman & Gustafson, 2004). In this section, we discuss teachers' role in the curriculum design process in each of these four paradigms and add some recent views and elaborations.

The *instrumental paradigm* is embedded in prescriptive theories. Prescriptive theories deal with questions about how to design the best possible curricula (Marsh & Willis, 2003). These theories focus on the development of heuristics that guide a high quality design process. Tyler's approach to curriculum design is a classical example (Tyler, 1949). He shifted the discussion from what teachers should do (teacher behaviour) to what students should learn (student behaviour). Tyler formulated four basic questions a curriculum designer must answer: (1) what is the purpose of education, resulting in the selection of objectives; (2) how to select learning experiences that foster the attainment of the objectives; (3) how to organize these learning experiences and (4) how to evaluate them on their effectiveness. Answers to these questions may be sought in philosophy, psychology, and from subject specialists. In addition, students' test results can help to diagnose needs and determine the outcomes of education. Tyler's approach is characterized as rational-linear, and is used for curriculum design at the school level, as well as for large-scale curriculum design and projects that are initiated outside the school. In Tyler's view, the teacher was responsible not so much for the ends of the curriculum (the purpose and the selection of objectives), but for the means (the selection and organization of learning experiences) (Clandinin & Connelly, 1992). Taba, another representative of the rational-linear approach, saw teachers as the ones who provide a supportive environment for learning (Marsh & Willis, 2003). Visscher-Voerman and Gustafson (2004) found that professional curriculum designers following the instrumental paradigm tried to get a clear picture of the needs of their clients as a first step in the design process (*analysis*), often with a focus on the needs of the end users (mostly students). *Design* and *development* activities focused on the creation of the products. *Evaluation* of the design often occurred only when the products were about to be finished and during *implementation* with users; the main concern of designers adhering to the instrumental approach was how end users (often students) used the products. In their view, teachers mediated the designed materials. In Chap. 2, Pareja Roblin and McKenney discuss teachers' involvement and roles in projects based on the Research, Development & Diffusion (RD&D) model, which represents a specific form of a rational-linear approach to curriculum design. In summary, in the instrumentalist paradigm, teachers are seen above all as implementers of curriculum; but, having said that, there is room for teachers to actively design learning experiences, possibly by making use of externally developed curriculum products. McKenney, Kali, Markuskauskaite, and Voogt (2015) analysed how teachers can be supported in technology-rich lesson design from an instrumental paradigm perspective. They identified powerful design heuristics that may help teachers design technology-rich lessons.

The *communicative paradigm* is rooted in descriptive theories about curriculum design (Marsh & Willis, 2003). Descriptive theories study what people actually do when they design curricula and are particularly concerned with how people arrive at answers. These theories are concerned with how decisions are made in the curriculum design process and provide a deep understanding of the complexity of the design and development process. Walker's (1971) deliberative approach to curriculum design is a prominent example of the communicative approach. He studied the decision-making processes taking place in large-scale curriculum design projects and found that the personal beliefs and values of those involved influence the curriculum design and development process. Walker argued that these values and beliefs need to be acknowledged and become explicit. In his view, curriculum design was basically a process of negotiation among key stakeholders. He proposed beginning with a platform for open discussion of ideas about the design task among all those involved, with the aim of reaching shared understanding and consensus. Only then could deliberations about concrete courses of action and design decisions occur. The transition from the platform of ideas to the phase of curriculum deliberations was fluid. Deliberations led to core decisions, which informed the design. Visscher-Voerman and Gustafson (2004) found that in a communicative approach, curriculum design is not seen as only the responsibility of professional designers, but that major stakeholders are often invited as co-designers. Other authors have also emphasized the importance of developing shared understanding about the design task among stakeholders, such as teachers. For example, McKenney et al. (2015) discussed how important it is to understand how teachers design and what their thinking is, in order to be able to provide them with appropriate support during the design process. Other studies in this book address the importance of a shared understanding of the design task by teacher designers (e.g., Handelzalts in Chap. 9 and Huizinga, Nieveen, & Handelzalts in Chap. 10). Kessels and Plomp (1999) reported about the importance of a relational (communicative) approach in curriculum design for realizing external consistency. External consistency refers to a shared understanding by the main stakeholders involved of the problem that needs to be solved in the curriculum design process. Their study showed that such shared understanding contributed to teamwork and active involvement in the implementation of the problem solution. Albashiry (Chap. 19) and Akomaning (Chap. 6) in this book confirm the importance of external consistency in collaborative teacher design. Walker's views have also been used in smaller curriculum design studies. For example, Boschman, McKenney, and Voogt (2014) used Walker's approach to analyse the design talk of kindergarten teachers when designing technology-rich activities to foster early literacy. They found that pedagogical practical considerations guided the design decisions of kindergarten teachers, and not so much up-to-date subject matter knowledge. To conclude, in a communicative approach to curriculum design the knowledge, beliefs and values of major stakeholders about the design task are shared and efforts are undertaken to reach consensus. Teachers are actively involved as major stakeholders in the design process, either as co-designers (in large-scale projects) or collaborating in a teacher team to design school-based curriculum innovations.

The essential starting point in the *artistic paradigm* is the individual process of construction of meaning, often based on the expertise and experience of the connoisseur (Visscher-Voerman & Gustafson, 2004). In essence, this paradigm can be assumed to be rooted in the theory of situated cognition (Greeno, 2011; Greeno et al., 1998; McKenney et al., 2015). This theory claims that knowing is rooted in social activities, context and culture. This view leads to questions such as how and why the curriculum has developed as it has and how it could be developing (Marsh & Willis, 2003). Eisner is a well-known representative of the artistic paradigm. He emphasized the artistry of curriculum making and emphasized that the curriculum is not static but dynamic, and constructed and reconstructed by those who enact it (Marsh & Willis, 2003). Eisner does not differ much from Tyler with regard to what must be addressed when designing curriculum, but in contrast to Tyler he did not see the design process as a linear process, but as an open-ended process in which means and ends are interdependent (Marsh & Willis, 2003; Visscher-Voerman & Gustafson, 2004). Eisner emphasized the complexity and the unexpected character of curriculum design and realized that in the end it is the teacher who decides what is being taught. In the artistic paradigm the teacher as designer of curriculum brings in his practical knowledge, his 'wisdom of practice', which is often implicit and tacit (Shulman, 1986). McKenney et al. (2015) argued teachers' who are designing need a basic understanding of what design and development work entails facilitates the design process. Huizinga, Nieveen, and Handelzalts (see Chap. 7) discuss the need for and scope of teacher design expertise. Thus, it seems important that teachers who are involved in design and development practices learn to make their knowledge explicit and relate it to the specific activities that are involved in curriculum design processes.

Finally, we briefly discuss the *pragmatic paradigm*. The basic interest of this paradigm is whether the design works in practice and is found useful by the end users (Visscher-Voerman & Gustafson, 2004). The pragmatic paradigm emerged from the practice of software engineering. Because of the increasing use of educational software in education, the pragmatic paradigm has increasingly influenced recent curriculum design practices (e.g., Schmidt & Fulton, 2016; Veletsianos, Beth, Lin, & Russell, 2016). An important characteristic of this approach is the limited attention to analysis, and the quick turn-around of prototypical products that are formatively evaluated by end users (Tripp & Bichelmeyer, 1990). It is a highly iterative approach, which leads incrementally to the final design. These prototypical products provide a concrete visual image of the innovation that is being developed at an early stage of the design process. The deliberations about these prototypes with teachers are important not only because of their knowledge of practice, but also because in this way teachers actively participate in the design process. Cober, Tan, Slotta, So, and Könings (2015) showed how teachers acted as co-designers through commenting on prototypes and, in this way, actually contributed to the design of the final product.

This section shed light on teacher roles in curriculum design. Four approaches to curriculum design processes have been discussed. The instrumental paradigm, as advocated by Tyler, has proved to be helpful in curriculum design processes because it contributes to the quality of the design – also referred to as internal consistency (Kessels & Plomp, 1999). In this paradigm the role granted to teachers is limited to the implementation of the curriculum. The instrumental paradigm falls short in not recognizing curriculum design as a process of interaction and negotiation. This notion is much better recognized and acknowledged in the other three paradigms, which have explicit and active roles for teachers as major stakeholders in curriculum design. Such an active role for teachers is important, not only because consensus and shared understanding about what the curriculum comprises is needed for the implementation of the curriculum, but also because teachers' wisdom of practice results in curricula that are more realistic and practical to implement. In addition, teachers' active role in curriculum design contributes to their professional learning, and both curriculum design and teachers' professional learning determine the quality of implementation of a curriculum innovation.

The Interaction Between Teachers and Curriculum Materials

In the previous section we reviewed the roles teachers typically have in various approaches to curriculum design. In this section we shift our attention to the interaction between teachers and the tangible outcome of the design process: curriculum materials. Curriculum materials are often considered an important means in realizing curriculum innovation, because they provide concrete support and suggestions for the enactment of the curriculum in classroom practice (Brown, 2009; Carlson & Anderson, 2002; Carlson, Davis, & Buxton, 2014).

Curriculum materials are tools that mediate teachers' activity in the classroom and can afford, but also constrain, the teacher's actions (Brown, 2009). The primary function of curriculum materials is to support teachers in enacting the curriculum. However, it is the teacher who decides how to use the materials. The teacher-curriculum encounter is a complex one. Ben-Peretz (1990) distinguished between the objective and the subjective interpretation of curriculum materials. The objective interpretation refers to the use of the materials as intended by the curriculum designers, while the subjective interpretation refers to the interpretation of curriculum materials by the teacher. The objective interpretation suggests that curriculum materials are used faithfully and serve as a means in realizing curriculum implementation. The underlying assumption is that the curriculum is fixed and should be implemented with *high fidelity*. In the subjective interpretation, curriculum materials are seen as embodiments of the potential of curriculum, which may be realized through teacher interpretation and professional imagination (Ben-Peretz, 1975). The subjective interpretation perceives curriculum materials from the perspective of teachers' active interpretation and work with curriculum materials (Brown, 2009; Remillard, 2005), and depends on experience, beliefs and context. This perspective allows for *mutual adaptation* and an *enactment perspective* on curriculum. Mutual adaptation refers to the evolution of the curriculum through the mutual learning and reshaping of the curriculum by designers and teachers (cf. Dede, 2006). The enactment perspective sees the teacher as a curriculum maker (Clandinin & Connelly, 1992), with regard to both the design and the implementation of curriculum.

Brown (2009) advocated that curriculum materials should no longer be designed as one-size-fits-all documents, but that they should be designed to support different modes of use by teachers. The need for this was confirmed in a study of Shawer (2010), who studied how experienced teachers interpreted and used curriculum materials. She found three types of relationships teachers had with curriculum materials: developers, makers and transmitters of curriculum. These three positions aligned well with a mutual adaptation, enactment or fidelity perspective on curriculum implementation (Snyder, Bolin, & Zumwalt, 1992). In each position, the teachers used specific strategies to cope with curriculum innovations and use curriculum materials. Most teachers in her study were *curriculum developers*. They adapted, expanded and supplemented the curriculum when they saw a need. They did that by using the curriculum materials as a framework for their teaching, adapting or skipping parts of the materials and using other sources when needed. *Curriculum makers* started with a needs analysis, designed their own curriculum materials and evaluated them. They referred to the curriculum, more than to specific curriculum materials, as the basis for their decisions. Finally, *curriculum transmitters* strictly followed the curriculum materials. Similar findings were observed in a study by Remillard and Bryans (2004). Thus, teachers display different relationships with curriculum materials, yet little is known about why these relationships differ and how they may impact teacher practices and student learning.

Well-designed curriculum materials help teachers to enact the curriculum as intended. However, research has shown that many textbooks and teacher guides often fail to help teachers understand the rationale behind the suggestions they offer for teaching and for monitoring student progress (Ball & Cohen, 1996; Valencia, Place, Martin, & Grossman, 2006). A strand of studies has focused on the potential of curriculum materials to help teachers to better understand the curriculum innovation and to provide them with specific support for enacting essential, but vulnerable elements of the curriculum innovation (Ball & Cohen, 1996; Davis & Krajcik, 2005; Van den Akker, 1988). The assumption underlying these studies is that curriculum materials designed with this purpose in mind can foster teacher learning and contribute to the implementation of curriculum innovations. Findings have shown that such curriculum materials indeed help teachers to change their teaching practice and provide a successful experience when teaching the innovative curriculum (e.g., Davis, Palincsar, Smith, Arias, & Kademian, 2017; Pareja Roblin, Schunn, & McKenney, 2018; Schneider & Krajcik, 2002; Van den Akker, 1988). However, researchers in this strand have also acknowledged that materials alone are not enough to realize the sustainable implementation of curriculum innovations. To have an impact on teacher behaviour and student learning in the long run, teachers' active involvement in their own professional learning is needed, so that they can adapt materials to their specific context and needs, based on an understanding of the intentions of the curriculum (Davis et al., 2017; Schneider, Krajcik, & Blumenfield, 2005; Thadani, Cook, Griffis, Wise, & Blakey, 2010).

Theoretical Conceptions Underpinning Collaborative Curriculum Design in Teacher Teams

In the two previous sections we discussed different roles for teachers in the process of curriculum design and we elaborated on the interaction between teachers and the product of the design process, the curriculum materials. In this section we discuss the importance of teacher involvement in curriculum design to produce curriculum materials that support curriculum implementation. Based on theoretical conceptions, we argue that collaborative curriculum design in teacher teams is essential for bridging the gap between curriculum intentions and realization, and for realizing a curriculum innovation with an important additional effect: teacher learning. Our work on collaborative design in teacher teams is informed by sociocultural theories about teacher learning and change. Three elements characterize these theories: learning is mediated through activity, learning is social in nature, and learning is situated and culturally embedded. Below, we elaborate on each of these elements.

Curriculum design is characterized by the development of concrete curriculum materials through active discourse. The joint feature of these materials is that they incorporate a plan for learning (Taba, 1962) that is the result of negotiation among involved stakeholders. These negotiations take place when teachers collaboratively design curriculum for targeted learners with specific objectives and content. The two basic elements of curriculum design, materials (tools) and discourse (speech), make curriculum design capable of being seen as a mediated activity (Vygotsky, 1978). Vygotsky (1978) argued that such mediated activity, the interaction between the curriculum materials (tools) and the articulated reflection on the purpose of the materials through discourse (speech), leads to learning. Thus, when teachers are actively involved in the process of curriculum design they develop a relationship with the curriculum through the curriculum materials that leads to teacher learning (Brown, 2009; Remillard, 2005).

The importance of collaboration between teachers during the design process is grounded in the social nature of the learning that takes place in collaborative design. Wenger (1998) introduced the concept of community of practice for a group of people with shared interests in a specific domain. As a community, they develop joint perspectives by sharing knowledge and experiences in solving problems they encounter, and they learn from each other in this process. Collaborative design in teacher teams is an example of a community of practice. During the process of collaborative curriculum design, teachers need to solve problems and make decisions (Walker, 1971). They need to articulate their (often tacit) practical knowledge (Verloop, Van Driel, & Meijer, 2001; Shulman, 1986) in order to develop a shared understanding of the problem and its possible solution. This process of interpretation and negotiation is not linear but iterative in nature, and leads to individual and collaborative learning (Clarke & Hollingsworth, 2002; Greeno, 2011; Wenger, 1998). Voogt et al. (2011) have shown that the interaction of teacher design teams with the external expertise brought in by a facilitator positively contributes to the quality of the design and to teachers' learning. Such external expertise can also take the form of existing curriculum materials, which can serve as examples to support teams of teachers in articulating their understanding of the innovation and the design task (Binkhorst, Poortman, & Van Joolingen, 2017). The importance of external expertise relates to Vygotsky's (1978) notion of the 'zone of proximal development'; a concept that Vygotsky (1978) used to describe the interaction between learning and development. In his view, learning takes place when actual development expands through interaction with experts and peers who bring in new knowledge. This notion of the 'zone of proximal development' is also relevant when to understand teacher learning when they interact with curriculum materials. Studies on effective professional development confirm the importance of collaboration for teacher learning (Garet, Porter, Desimone, Birman, & Yoon, 2001; Whitcomb, Borko, & Liston, 2009).

The theory of situated cognition (Greeno, 2011; Greeno et al., 1998) postulates that the behaviour of individuals can be understood from the behaviour of the social system to which the individuals belong. Hence, the behaviour of individual teachers is deeply embedded in the system called school (Sarason, 1996). The school as a social system for the teacher becomes reality in the specific contextual experiences of a specific teacher as well as in the accumulated experiences of all teachers. What a teacher brings to the design process is thus mainly determined by the specific and universal demands, opportunities and constraints of the school (Janssen, Westbroek, Doyle, & Van Driel, 2013). This situative view implies that teacher learning and change through curriculum design can only be meaningful when the culture and context of the school are an integral part of the process. We argue that the process of collaborative curriculum design by teachers is, by its nature, culturally embedded and situated, and therefore offers a perfect environment for teacher learning.

Teachers bring their knowledge and experience to the design process, they negotiate solutions for the design problems they face, they develop concrete curriculum materials and they (ideally) formatively evaluate these (interim) products through implementing them in their teaching practice. These specific characteristics of collaborative curriculum design thus guarantee a learning process that is situated and culturally embedded. Several studies reflecting on effective characteristics of teacher professional development have pointed to the importance of embedding teacher learning in actual teaching practice (e.g., Borko, 2004; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Penuel et al. 2007; Putnam & Borko, 2000).

Teacher learning and the consequent change processes taking place in collaborative curriculum design activities are cyclical in nature. This type of learning is captured in the model of expansive learning proposed by Engeström (2006). According to this model, the learning and change process consists of a sequence of epistemic actions, going from questioning aspects of the existing practice, to analysing the situation, modelling alternatives in a visible and transmittable medium, examining the model, experimenting with it to grasp its actual contour and possible limitations, implementing the model with enrichments and conceptual extensions, and then reflecting on the process and consolidating it toward becoming a stable form of new practice (Engeström & Sannino, 2010). This process, when done collaboratively, brings about agency that is both collective and distributed. Expansive cycles correspond to a learning process that includes both internalization and externalization. When teachers are designing new curriculum or new learning activities, they need to engage in reflective analysis of what exists (internalization) and to design and implement new models (externalization). Thus, in collaborative curriculum design, teachers have a key role in curriculum design and innovation. On the one hand, they are participating in a social learning process that has an impact on their professional learning and on their sense of ownership of the innovation. On the other hand, they realize a high quality curriculum innovation through their participation as a community in a collaborative design process that aims at the design of curriculum materials that are relevant, consistent, feasible and effective (Nieveen, 2009).

This Book

In this book, we present studies that start from the perspective that teachers are curriculum makers who actively design curriculum in collaboration with colleagues. The conceptualizations above have shown that both the process and products of curriculum design may contribute to teacher learning. We also showed that through their active involvement in shaping curriculum materials, teachers assume agency for how the materials transform their teaching and may contribute to student learning. When teachers collaboratively design curriculum, they share this agency. Voogt et al. (2015) used the term *shared transformative agency* to describe this process. They argued that teacher involvement in collaborative curriculum design increases the chance that teachers as a team develop ownership for the design and that shared responsibility contributes to sustainable implementation of the design in classroom practice. The contributions in the present book aim to deepen our knowledge of collaborative curriculum design in teacher teams and its impact on teacher learning and sustainable curriculum implementation.

References

Alexander, R. J., & Flutter, J. (2009). *Towards a new primary curriculum: A report from the Cambridge primary review. Part 1: Past and present*. Cambridge, UK: University of Cambridge Faculty of Education.

Ball, D., & Cohen, D. (1996). Reform by the book: What is – or might be – the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6–8. 14.

Ben-Peretz, M. (1975). The concept of curriculum potential. *Curriculum Theory Network, 5*, 151–159.

Ben-Peretz, M. (1990). *The teacher-curriculum encounter*. Albany, NY: State University of New York Press.

Binkhorst, F., Poortman, C., & van Joolingen, W. (2017). A qualitative analysis of teacher design teams: In-depth insights into their process and links with their outcomes. *Studies in Educational Evaluation, 55*, 135–144.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*, 3–15.

Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. *Educational Technology Research and Development, 62*, 393–416.

Brown, M. (2009). The teacher-tool relationship: Theorizing the design and use of curriculum materials. In J. T. Remillard, B. Herbel-Eisenman, & G. Lloyd (Eds.), *Mathematics teachers at work: Connecting curriculum materials and classroom instruction* (pp. 17–36). New York: Routledge.

Carlson, J., & Anderson, R. (2002). Changing teachers' practice: Curriculum materials and science education reform in the USA. *Studies in Science Education, 37*(1), 107–135.

Carlson, J., Davis, E. A., & Buxton, C. (2014). *Supporting the implementation of the Next Generation Science Standards (NGSS) through research: Curriculum materials*. Retrieved from https://narst.org/ngsspapers/curriculum.cfm

Clandinin, J., & Connelly, F. (1992). Teacher as curriculum maker. In P. Jackson (Ed.), *Handbook of research on curriculum* (pp. 363–401). New York: Macmillan.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*, 947–967.

Cober, R., Tan, E., Slotta, J., So, H.-J., & Könings, K. D. (2015). Teachers as participatory designers: Two case studies with technology-enhanced learning environments. *Instructional Science, 43*, 203–228.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the United States and abroad*. Washington, DC: National Staff Development Council.

Davis, E., & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. *Educational Researcher, 34*(3), 3–14.

Davis, E. A., Palincsar, A. S., Smith, P. S., Arias, A. M., & Kademian, S. M. (2017). Educative curriculum materials: Uptake, impact, and implications for research and design. *Educational Researcher, 46*(6), 293–304.

Dede, C. (2006). Scaling up: Evolving innovations beyond ideal settings to challenging contexts of practice. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 551–566). Cambridge, UK: Cambridge University Press.

Engeström, Y. (2006). Activity theory and expansive design. In S. Bagnara & G. Crampton Smith (Eds.), *Theories and practice in interaction design: Interaction design* (pp. 3–25). New York: Lawrence Erlbaum.

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review, 5*(1), 1–24.

Fullan, M. (1991). *The new meaning of educational change* (2nd ed.). London: Casell Educational Limited.

Fullan, M. (2008). Curriculum implementation and sustainability. In M. F. Connelly, M. F. He, & J. Philion (Eds.), *The sage handbook of curriculum and instruction* (pp. 113–122). London: Sage.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*, 915–945.

Greeno, J. G. (2011). A situative perspective on cognition and learning in interaction. In T. Koschmann (Ed.), *Theories of learning and studies of instructional practice* (Vol. 1, pp. 41–71). New York: Springer.

Greeno, J. G., & Middle School Mathematics through Applications Project Group. (1998). The situativity of knowing, learning, and research. *American Psychologist, 53*(1), 5–26.

Haug, P. (2003, May). The evaluation of reform 97: Key findings. Paper presented at the concluding session of the Programme for the Evaluation of Reform 97, Folkets hus, Oslo, Norway.

Janssen, F., Westbroek, H., Doyle, W., & Van Driel, J. H. (2013). How to make innovations practical. *Teachers College Record, 115*, 1–42.

Kessels, J., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709.

Marsh, C. J., & Willis, G. (2003). Approaches to curriculum. In *Curriculum: Alternative approaches, ongoing issues* (3rd ed.) (pp. 66–92). Upper Saddle River, NJ: Pearson Education.

McKenney, S. E., Kali, Y., Markuskauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: An ecological framework for investigating assets and needs. *Instructional Science, 43*, 181–202.

Niederhauser, D., Howard, S., Voogt, J., Agyei, D., Laferrière, T., Tondeur, J., & Cox, M. (2018). Sustainability and scalability in educational technology initiatives: Research-informed practice. *Technology, Knowledge and Learning, 23*, 3.

Nieveen, N. (2009). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 89–101). Enschede, The Netherlands: SLO.

Pareja Roblin, N., Schunn, C., & McKenney, S. (2018). What are critical features of science curriculum materials that impact student and teacher outcomes? *Science Education, 102*(2), 260–282.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211–246.

Remillard, J. T., & Bryans, M. B. (2004). Teachers' orientations towards mathematics curriculum materials: Implications for teacher learning. *Journal for Research in Mathematics Education, 35*(5), 352–388.

Sarason, S. S. (1996). *Revisiting "the culture of the school and the problem of change"*. New York: Teachers College Press.

Schmidt, M., & Fulton, L. (2016). Transforming a traditional inquiry-based science unit into a STEM unit for elementary pre-service teachers: A view from the trenches. *Journal of Science Education and Technology, 25*(2), 302–315.

Schneider, R. M., & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. *Journal of Science Teacher Education, 13*(3), 221–245.

Schneider, R. M., Krajcik, J., & Blumenfeld, P. (2005). Enacting reform-based science materials: The range of teacher enactments in reform classrooms. *Journal of Research in Science Teaching, 42*, 283–312.

Shawer, S. F. (2010). Classroom-level curriculum development: EFL teachers as curriculum-developers, curriculum-makers and curriculum-transmitters. *Teaching and Teacher Education, 26*(2), 173–184.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*, 4–14.

Snyder, J., Bolin, F., & Zumwalt, K. (1992). Curriculum implementation. In P. Jackson (Ed.), *Handbook of research on curriculum* (pp. 402–435). New York: Macmillan.

Stenhouse, L. (1975). *An introduction to curriculum research and development*. Oxford, UK: Heinemann Educational Books Ltd.

Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt, Brace & World.

Thadani, V., Cook, M. S., Griffis, K., Wise, J. A., & Blakey, A. (2010). The possibilities and limitations of curriculum-based science inquiry interventions for challenging the "pedagogy of poverty". *Equity & Excellence in Education, 43*(1), 21–37.

Tripp, S. D., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development, 38*(1), 31–44.

Tyler, R. W. (1949). *Basic principles of curriculum and instruction*. Chicago: University of Chicago Press.

Valencia, S., Place, N., Martin, S., & Grossman, P. (2006). Curriculum materials for elementary reading: Shackles and scaffolds for four beginning teachers. *The Elementary School Journal, 107*(1), 93–120.

Van den Akker, J. (1988). The teacher as learner in curriculum implementation. *Journal of Curriculum Studies, 20*(1), 47–55.

Van den Akker, J. (2003). Curriculum perspectives: An introduction. In *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Veletsianos, G., Beth, B., Lin, C., & Russell, G. (2016). Design principles for thriving in our digital world: A high school computer science course. *Journal of Educational Computing Research, 54*(4), 443–461.

Verloop, N., Van Driel, J. H., & Meijer, P. C. (2001). Teacher knowledge and the knowledge base of teaching. *International Journal of Educational Research, 35*, 441–461.

Visscher-Voerman, J. I. A., & Gustafson, K. (2004). Paradigms in the theory and practice of education and training design. *Educational Technology, Research & Development, 52*(2), 69–89.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R., Hickey, D., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science, 43*, 259–282.

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235–1244. https://doi.org/10.1016/j.tate.2011.07.003.

Vygotsky, L. S. (1978). Mind in society. In *The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walker, D. F. (1971). A study of deliberation in three curriculum projects. *Curriculum Theory Network*, (7), 118–134.

Walker, D. F. (2003). *Fundamentals of curriculum; passion and professionalism* (2nd ed.). New York: Routledge.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge, UK: Cambridge University Press.

Whitcomb, J., Borko, H., & Liston, D. (2009). Growing talent: Promising professional development models and practices. *Journal of Teacher Education, 60*(3), 207–212.

Williamson, B. (2013). *The future of the curriculum. School knowledge in the digital age*. Cambridge, MA: The MIT Press.

Chapter 2
Classic Design of Curriculum Innovations: Investigation of Teacher Involvement in Research, Development, and Diffusion

Natalie Pareja Roblin and Susan McKenney

Introduction

The improvement of educational practice through research is a topic of ongoing debate. In education and other fields, the last decades have witnessed a renaissance of interest in knowledge mobilization and research use, and particularly in the role of empirical evidence in informing practice (Farley-Ripple, May, Karpyn, Tilley, & McDonough, 2018; Levin, 2013; Nutley, Jung, & Walter, 2009). However, despite this renewed interest, various studies have suggested that relationships between research and practice in education remain rather weak (e.g., Hemsley-Brown & Sharp, 2003; Vanderlinde & van Braak, 2010). Multiple reasons have been identified in the literature to explain why these relationships are so difficult to build (cf. Broekkamp & Van Hout-Wolters, 2007; Burkhardt & Schoenfeld, 2003; Kennedy, 1997). One reason pertains to the *relevance* of educational research for classroom practice. It is often argued that the types of problems addressed by educational researchers are typically different from the types of problems experienced by teachers in their daily work, and therefore lack practical meaning (Broekkamp & Van Hout-Wolters, 2007; Burkhardt & Schoenfeld, 2003; Kennedy, 1997). Another reason relates to different *interests and goals* between teachers and researchers, which ultimately call for two distinct types of knowledge (McIntyre, 2005): while researchers seek for generalizable and abstract propositions, teachers look for practical and concrete recommendations that can assist them in dealing

N. Pareja Roblin (✉)
University of Applied Sciences, Amsterdam, The Netherlands
e-mail: n.n.pareja.roblin@hva.nl

S. McKenney
Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands
e-mail: susan.mckenney@utwente.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_2

with the complexities and uniqueness of their classroom practice. A third commonly acknowledged reason pertains to the *accessibility* of research findings. The literature has suggested that teachers rarely use research to inform their practice because (i) academic journals are inaccessible to non-academic audiences (Hemsley-Brown & Sharp, 2003), (ii) teachers lack the time to read research and make sense of it (Burkhardt & Schoenfeld, 2003), and/or (iii) teachers experience difficulties in translating the rather general and abstract propositions of research findings into the specificities and peculiarities of their classroom practice (Broekkamp & Van Hout-Wolters, 2007).

Different models to facilitate the diffusion and use of educational research have been developed and adopted over time. Three such models have commonly been identified in the literature: linear models, context-focused models, and interactive models (cf., Bauer & Fischer, 2007; Landry, Amara, & Lamari, 2001; Nutley, Walter, & Davis, 2007). *Linear models*, also known as "science-push" models (Landry et al., 2001), emphasize the unidirectional flow of knowledge from research to practice (Nutley et al., 2007). Central to these models is the need to make research conceptually and physically accessible to teachers through various translation and dissemination efforts. *Context-focused models*, also known as "demand-pull" models (Landry et al., 2001), focus on teachers' needs and on the contextual factors that shape the uptake of research. Although context-focused models allow for some degree of interaction between researchers and practitioners, this interaction is typically limited to the beginning (identification of needs and research problem) and the end (dissemination) of the research process (Bauer & Fischer, 2007). Finally, *interactive models* emphasize the multidirectional flow of knowledge between researchers and teachers, each bringing their own values and perspectives (Nutley et al., 2007). Continuous involvement of teachers throughout the research process and not only at the beginning and/or at the end is thus regarded as essential (Bauer & Fischer, 2007).

Although recent calls for strengthening research and practice relationships stress the need for new forms of collaboration and increased interaction between researchers and practitioners (de Vries & Pieters, 2007; Farley-Ripple et al., 2018; Levin, 2013; Penuel, Allen, Coburn, & Farrell, 2015), linear models have remained predominant for many decades (cf. Blakely et al., 1987; Posner, 2004; Schumacher, 1972; Thomas & Pring, 2004). In this chapter, we examine a linear model that is prominently present in the design of curriculum innovations intended for large-scale implementation: the Research Development and Diffusion (RD&D) model. The ultimate goal is to gain a better understanding of how research and practice relationships are shaped in RD&D projects, and to ascertain *whether* and *why* the claimed benefits for and criticisms of this model are (still) warranted.

Theoretical Underpinnings

Characterizing the Research-Development-Diffusion Model

The RD&D model was conceived from the perspective of developing and implementing research-based curriculum innovations (Gottschalk et al., 1981 Havelock, 1969). RD&D is generally characterized as being rationalistic, sequential, comprehensive and complex (Schumacher, 1972). It is *rationalistic* because it requires deliberate and systematic planning; *sequential* because research, development and diffusion activities follow a linear order; *comprehensive* because planning and development typically occur on a large scale; and *complex* because it requires the involvement of various participants and organizations. In the RD&D model, the process of educational change is regarded as a systematic sequence of tasks that begins with the identification of a problem on the basis of a perceived need, then continues with the exploration and application of scientific principles for the development and evaluation of a research-based solution to this problem, and ultimately ends with the diffusion of the developed solution to the target group (Havelock, 1969; Posner, 2004).

Three distinct phases can be identified in the RD&D model: research, development, and diffusion. The goal of the first phase, *research*, is to advance knowledge in the field. Although the research may or may not be directly concerned with a specific problem from educational practice, its results serve to inspire development activities. The second phase, *development*, aims at translating existing knowledge from research into the design of a solution for an actual problem. Along with design activities, the development phase typically includes the systematic testing and evaluation of the developed solution to assess its quality, utility, value and feasibility in natural settings. Finally, *diffusion* aims at facilitating dissemination and adoption. This third phase is typically broken down into specific activities aimed at creating awareness, demonstrating effectiveness and utility, and providing training and support (Clark & Hopkins, 1969; Havelock, 1969).

Guba and Clark (in Havelock, 1969) argue that it is through this cycle of research, development and diffusion activities that the RD&D model contributes to building stronger relationships between research and practice. Research utilization and dissemination play a key role in this process. Research utilization alludes to the application of (scientific) knowledge. In the RD&D model, research utilization typically takes place when curriculum developers make deliberate use of relevant evidence from scientific research to inform the development of curriculum innovations. This knowledge, once embodied in curriculum frameworks and/or materials, needs to be communicated to the target users to facilitate acceptance and adoption through various dissemination activities. Hence, the effectiveness of the RD&D model in connecting research and practice is dependent on both, successful research utilization and dissemination.

To understand the relationships between research and practice across RD&D projects, three dimensions warrant consideration: (i) the participants involved throughout the RD&D process and their roles, (ii) the types of knowledge used to inform the design of curriculum innovations; and (iii) the activities undertaken to facilitate diffusion and adoption. Taken together, these dimensions formed the analytical framework used in this study. In the next section we turn to each of these dimensions.

A Framework for Analysing Research and Practice Relationships

Participants' Roles in RD&D-Based Projects

The core phases of research, development, and diffusion are often implemented by multiple (groups of) participants and organizations. Havelock (1969) distinguished three major roles in RD&D projects, each related to a specific phase of the model: researcher, developer, and linkage agent. The researcher role consists of gaining a better understanding of an educational phenomenon, and thereby providing a general knowledge base that (potentially) can be used to inform development. The developer role, sometimes also undertaken by applied researchers, encompasses the design and evaluation of a solution to an identified problem. The linkage agent role entails the diffusion of the developed solution through various dissemination and training activities. Although the linear character of RD&D has remained, over the years more emphasis has been given to involving teachers throughout the process, especially during development (Blakely et al., 1987).

Types of Knowledge Informing Curriculum Design

In RD&D, one of the main sources informing the curriculum design process is the knowledge generated through scientific research. Developers are expected to search for and make use of relevant research knowledge (Brickell in Havelock, 1969). Knowledge generated through scientific inquiry can be communicated to the developers explicitly (e.g., through books, research articles) or implicitly (e.g., through personal interactions during coaching and supervision) (Nonaka & Takeuchi, 1995). Besides the knowledge derived from the research literature, evidence collected during evaluation studies aimed at testing and assessing the overall quality of the curriculum innovation constitutes another key source of knowledge informing curriculum design (Havelock, 1969). The results of these evaluation studies are typically used to determine the utility and feasibility of the curriculum innovation in real settings, and hence they contribute to further adjustment of its characteristics to the context and needs of potential users. Finally, the RD&D model also acknowledges that the development process can be informed by experience and intuition (Guba & Clark in Havelock, 1969), increasingly recognized in the literature as another type of knowledge (Gibbons et al., 1994; Thomas & Pring, 2004). The expertise of researchers, developers, content experts and/or practitioners can therefore be considered as a third source of knowledge that can potentially guide curriculum design.

Diffusion

In the traditional RD&D model, diffusion is viewed as a one-way process, and hence has much in common with Rogers' (2003) model of diffusion of innovations. In this model, diffusion progresses through five main phases (Rogers, 2003): (1) knowledge (awareness that the innovation exists); (2) persuasion (interest in the innovation); (3) decision (adopt or reject); (4) implementation (trial); and (5) confirmation (continuing and or extending use). At the same time, the educational change research has emphasized the need to consider how stakeholders experience innovation and especially the diffusion/adoption process, and to design interventions accordingly (cf. Fullan, 2007; Hall & Hord, 2010). This suggests the need for a bilateral relationship between development and diffusion.

Based on the framework described above, the current study aimed at gaining a better understanding of research and practice relationships across a set of studies reporting on the design of curriculum innovations featuring key characteristics of RD&D as described above: systematically applying scientific principles for the development of a research-based solution to a perceived problem, following a linear sequence of research, development and diffusion activities, and involving various participants and organizations. The research questions guiding the study were:

1. What participants are involved in curriculum innovation projects featuring RD&D characteristics, and what are their main roles?
2. What sources of knowledge are used to inform the design of curriculum innovations?
3. What activities are undertaken to facilitate diffusion and adoption of the curriculum innovations?

Methods

Selection of Projects

General descriptors distilled from the literature characterizing the RD&D model were used to search for relevant projects, including terms reflecting the nature of the curriculum innovations under development (e.g., evidence-informed, evidence-based), terms related to the different phases of the research and development process (e.g., design, development, pilot study), and terms associated with the diffusion of curriculum innovations (e.g., dissemination, diffusion, adoption). The search was conducted in three scientific databases (ERIC, Scopus, Web of Science) and limited to articles published in 2008 and in 2009, to allow for in-depth analysis of projects featuring characteristics of the RD&D model. This yielded a total of 1082 articles. Criteria used to select the projects are described in Table 2.1.

Abstracts were independently screened by two researchers and differences in judgement were discussed until agreement was reached. This procedure led to the identification of 181 studies that met the inclusion criteria. In the next step, the full-text articles were screened using the same inclusion criteria, but paying particular attention to the presence of descriptions of how research informed the design of curriculum innovations. This step further reduced the sample to nine studies. The excluded studies did not explicitly address how research contributed to the design of the curriculum innovation. Most of them reported findings from evaluation studies, without documenting the process through which the curriculum innovation was developed or the ways in which findings from the evaluation studies contributed to informing further development cycles.

Data Analysis

A semi-structured template was developed to capture information extracted from each article concerning the project's characteristics (e.g., name, country, goals), the study design (e.g., research questions, data collection methods), and the types of curriculum innovations designed (e.g., curriculum framework, curriculum materials). Participant involvement was analyzed through the identification of participants' professions (e.g., researcher, teacher, content specialist) and roles (e.g., researcher, developer, trainer), and descriptions of the specific activities undertaken by each. References to the knowledge sources informing the design of curriculum innovations were coded as research literature, data collected through needs assessments and/or formative evaluations, or project team's practical knowledge. Activities undertaken to facilitate dissemination and adoption were analyzed by identifying

Table 2.1 Inclusion criteria

Criteria	Description
Educational orientation	The project described was developed either within a formal educational setting (i.e., primary, secondary or tertiary education) and/or as part of a teacher professional development program
Participants	The project involved the participation of (student) teachers, university researchers and/or teacher educators
Research use	The article discusses how research informed the design of curriculum innovations, making explicit reference to the use of academic literature, results from evaluation studies and/or the expertise of the project team
Empiricism	The study reports the collection and analysis of empirical data

the main goal (e.g., develop ownership, create awareness, train teachers) and format (e.g., workshop, school meetings, curriculum materials) of each activity.

Common patterns and themes were identified across projects through constant comparison (cf. Denzin & Lincoln, 2000). After analyzing all nine articles, findings were discussed first within the research team and then in a working conference involving scholars with expertise on (bridging) the research-practice gap.

Findings

Characteristics of the Projects Included in the Review

As illustrated in Table 2.2, the nine projects studied reflect ample variation in location, target educational level, and subject area, including projects from the USA ($n = 4$), The Netherlands ($n = 3$), Canada ($n = 1$), and Germany ($n = 1$). The target educational level ranged from pre-school to higher education. Almost half of the projects ($n = 4$) focused on physical education, while the remaining projects focused on diverse subject areas such as mathematics, cartography and pediatrics. All projects had a clear focus on the design of curriculum innovations intended for large-scale use, a distinctive feature of the RD&D model. Initiatives and/or conditions for systematically disseminating the innovation to a larger number of schools, teachers and students were explicitly addressed in all the studies.

Table 2.2 Overview of project characteristics

Type of curriculum innovation	Authors	Country	Target educational level	Subject area	Phase reported
Curriculum framework	Balram and Dragicevic	Canada	Higher education	Cartography	Pilot implementation
	Kittredge et al.	USA	Higher education	Pediatrics	Dissemination
	Stone et al.	USA	High school	Mathematics	Summative evaluation
	Mooij	Netherlands	Pre-school	Gifted students	Pilot implementation
Health promotion program	Berger et al.	Germany	High school	Not specified	Formative evaluation
	Jurg et al.	Netherlands	Primary schools	Physical education	Formative evaluation
	Jansen et al.	Netherlands	Primary schools	Physical education	Summative evaluation
	Carlson et al.	USA	Primary schools	Physical education	Formative evaluation
	Williams et al.	USA	Pre-school	Physical education	Formative evaluation

When looking at the nature of the curriculum innovations developed, two different types of projects can be identified. One type may be labeled as *health promotion projects*, and includes projects concerned with the development of school-based interventions focused on the primary prevention of eating disorders (Berger, Sowa, Bormann, Brix, & Strauss, 2008) or on the promotion of physical activity and healthy nutrition (Carlson et al., 2008; Jansen et al., 2008; Jurg, De Meij, Van Der Wal, & Koelen, 2008; Williams, Carter, Kibbe, & Dennison, 2009). A second type may be labeled as *curriculum framework projects* and includes projects concerned with the development of frameworks to assist teachers in the design of innovative learning activities (Balram & Dragicevic, 2008; Kittredge, Baldwin, Bar-On, Trimm, & Beach, 2009; Mooij, 2008; Stone, Alfeld, & Pearson, 2008).

Participants' Roles

Three major groups of participants can be identified across the nine projects: university researchers, content specialists (e.g., health care professionals, educational consultants, programming experts), and teachers. In addition to these groups, three projects (Berger et al., 2008; Jansen et al., 2008; Jurg et al., 2008) referred to the involvement of local organizations during implementation and/or diffusion activities (e.g., local health services, sport clubs). Even though slight variations can be identified across projects, the overall roles and activities within each of these groups of participants were largely comparable.

In all projects, university researchers adopted a central role in assessing the quality, utility, feasibility and/or effectiveness of the curriculum innovation. Hence, they were responsible for designing pilot and effectiveness studies, collecting data, and reporting findings. In addition to these activities, university researchers were actively involved in the design process, often in collaboration with content specialists. Moreover, a couple of projects referred to the role of university researchers as trainers (Williams et al., 2009) or facilitators (Mooij, 2008) who coached teachers and/or assisted other experts in teacher training activities during (pilot) implementation.

Along with university researchers, seven out of nine projects reported the participation of content specialists. These included educational consultants (Kittredge et al., 2009; Stone et al., 2008), partners for math teachers (Stone et al., 2008), and health care professionals (Berger et al., 2008; Carlson et al., 2008; Jansen et al., 2008; Jurg et al., 2008; Williams et al., 2009). The role of content specialists usually consisted of contributing to the design of the curriculum innovation (Carlson et al., 2008; Jurg et al., 2008; Kittredge et al., 2009; Stone et al., 2008; Williams et al., 2009), assisting researchers with data collection (Jansen et al., 2008), and/or providing professional advice to teachers and students during implementation (Berger et al., 2008; Carlson et al., 2008; Stone et al., 2008).

More than a half of the studies explicitly referred to teacher involvement in the design of the curriculum innovations, through their participation in the project team (Williams et al., 2009; Kittredge et al., 2009), their contributions to focus group discussions about their specific needs and viewpoints (Carlson et al., 2008), or their feedback on the quality and effectiveness of earlier prototype versions of the curriculum innovation (Jurg et al., 2008; Williams et al., 2009). In one project (Stone et al., 2008), teachers were actively involved in translating the curriculum framework developed by the research team into concrete lesson plans to be implemented in their own classrooms. Finally, two studies reported teacher involvement in disseminating information about the curriculum innovation to other teachers (Kittredge et al., 2009; Mooij, 2008).

The involvement of local organizations, such as municipal health services or sport clubs, was reported in three *health promotion projects* (Berger et al., 2008; Jansen et al., 2008; Jurg et al., 2008). When involved, these organizations were typically responsible for assisting teachers and project leaders with the implementation of sports activities, or for the diffusion of the program to a larger number of schools in the region.

Sources of Knowledge Used to Inform the Design Process

Table 2.3 presents an overview of the various sources of knowledge informing the design of the curriculum innovations. As it could be expected, in all projects the design process was largely informed by the scientific research literature. General theories derived from the fields of education (e.g., contextual learning, constructivism) and psychology (e.g., theory of planned behavior, social cognitive theory), as well as recent research findings related to the projects' particular area of focus (e.g., mathematics education, pediatrics, gifted students) guided curriculum design choices.

Table 2.3 Knowledge sources informing the development of curriculum innovations

Type of curriculum innovation	Author	Research literature	Data from needs assessment	Data from pilot study/formative evaluation	Expertise of multidisciplinary team
Curriculum framework	Balram and Dragicevic	X	X		
	Kittredge et al.	X	X	X	X
	Stone et al.	X			X
	Mooij	X			
Health promotion program	Berger et al.	X		X	
	Jurg et al.	X		X	
	Jansen et al.	X			
	Carlson et al.	X	X	X	
	Williams et al.	X		X	

Note: X = used to inform the curriculum design process

Along with relevant scientific research literature, six out of nine projects explicitly reported the use of data collected during the project to inform the curriculum design process. More specifically, data from needs assessments (Balram & Dragicevic, 2008; Carlson et al., 2008; Kittredge et al., 2009) and/or formative evaluations (Berger et al., 2008; Carlson et al., 2008; Jurg et al., 2008; Kittredge et al., 2009; Williams et al., 2009) were instrumental in tailoring the curriculum innovations to the specific needs, expectations, motivation level, and/or educational background of potential users. Interestingly, only two projects (Kittredge et al., 2009; Stone et al., 2008) explicitly acknowledged that curriculum design was also informed by the practical knowledge of researchers and content specialists from various disciplines participating in the project team. Although the remaining projects also often involved experts from multiple disciplines, the ways in which their specific expertise informed the design process was not addressed in the articles.

In sum, scientific research knowledge typically shaped the development process in two ways. On the one hand, research literature and general educational or psychological theories were used to inform curriculum design choices. On the other hand, findings from needs assessments and/or formative evaluations were used to adjust the characteristics of the curriculum innovation to the context of implementation and to the specific needs and characteristics of potential users. By anticipating large-scale implementation through the identification of user needs and factors that could potentially influence later use, projects attempted to strengthen the relationships between research and practice.

Diffusion Activities

Across projects, various activities were systematically planned to facilitate the diffusion of the developed curriculum innovations. These activities aimed at generating a sense of ownership, creating awareness of the availability and benefits of the innovation among school staff and parents, and providing teachers with professional development and support.

Teacher Ownership

Over half of the projects ($n = 5$) reported active teacher involvement in the design process. Teacher involvement was encouraged in various ways across projects, including: (i) inviting teachers to participate in the project team (e.g., Williams et al., 2009) or in curriculum writing/reviewing subcommittees (e.g., Kittredge et al., 2009); (ii) organizing teacher teams to encourage the application of the curriculum framework in the design of enhanced lesson plans (e.g., Stone et al., 2008); and (iii) arranging focus group discussions (e.g., Carlson et al., 2008) or individual meetings (e.g., Mooij, 2008) to give teachers and other stakeholders the opportunity to express their viewpoints and concerns with regard to the (ideal) characteristics of the curriculum innovation. Despite the differences between these initiatives, they all shared the goal of facilitating active teacher engagement beginning at early stages in the design process.

Awareness

Activities to generate awareness about the need for and the benefits of the curriculum innovation among teachers, school staff and (particularly) parents were mainly reported across *health promotion projects*. Awareness was generally facilitated through school meetings (Berger et al., 2008; Jansen et al., 2008) and monthly newsletters (Carlson et al., 2008). During these activities, parents and school staff members received further information about the goals of the curriculum innovation, its characteristics and importance. Finally, in Williams et al. (2009), awareness of the innovation and its importance was encouraged by asking teachers to count their daily steps with the use of pedometers, thereby motivating them to increase their alertness regarding physical activity patterns in their students.

Professional Development and Support

Teacher training and support activities took the form of workshops (e.g., Kittredge et al., 2009; Stone et al., 2008), exemplary curriculum materials (Berger et al., 2008; Carlson et al., 2008; Jurg et al., 2008; Williams et al., 2009), demonstrations (e.g., Kittredge et al., 2009; Stone et al., 2008), and coaching (e.g., Mooij, 2008; Stone et al., 2008). Workshops were usually brief in duration (e.g., 1 or 2 h) and were often led by a member of the project team. The goal of these workshops was to provide teachers with general information about the curriculum innovation and how it could be used in their own classrooms.

Exemplary curriculum materials were typically designed by the project team to assist teachers in the implementation of the curriculum innovation. These materials could include: a suite of instruments to follow up on students' physical activity together with a list of recommended school exercise activities (e.g., Jurg et al., 2008); copies of the curriculum and a list with instructions on how to use it (e.g., Carlson et al., 2008); curriculum units and exemplary physical activities (e.g., Williams et al., 2009); and/or posters and guidelines to encourage group discussions (e.g., Berger et al., 2008). Besides exemplary curriculum materials, demonstration activities were sometimes organized to provide teachers with the opportunity to see live examples of how the curriculum innovation could be implemented. Demonstrations took the form of showcase events (e.g., Kittredge et al., 2009) or teacher presentations (e.g., Stone et al., 2008).

Coaching activities took place during (pilot) implementation and aimed at supporting teachers with the use of the curriculum innovation. In the project described by Mooij (2008), the coaching role was adopted by the researcher himself, whereas in Stone et al. (2008), partners for math teachers adopted this role. Finally, Carlson et al. (2008) reported coaching activities in which graduate students from health-related professions (e.g., kinesiology, dietetics) acted as mentors/coaches of teachers and students during the implementation of the new learning activities.

Discussion

The present study aimed to explore how research and practice relationships materialize across curriculum innovation projects that feature core characteristics of the RD&D model. These relationships were analyzed in relation to the participants involved in the project and their roles, the types of knowledge used to inform curriculum design, and the activities undertaken to facilitate diffusion and adoption. The rigorously defined set of articles that were included in our study provides a clear overview of what RD&D-model based projects look like. Using this information, we discuss the contributions of the RD&D model to strengthening research and practice relationships in education, as well as the criticisms of this model.

Overall, our findings confirm that the RD&D model lives up to its potential to promote active utilization of scientific research for the development of curriculum innovations. All projects that were analyzed reported the use of scientific research literature as a major source of knowledge guiding the curriculum design process. In addition to this literature, the knowledge derived from systematic formative evaluation studies was central for tailoring the characteristics of the curriculum innovation to the context and needs of the target audience. Our findings also reveal that in some cases the design process was informed by the practical knowledge and expertise of the project team, particularly when design activities were undertaken by a multidisciplinary group. Notably, in over half of the studies, teachers' opinions, suggestions and practical experiences were used to inform the design process.

Another key finding of our study is concerned with the identification of the participants involved in RD&D-based projects and their specific roles. Three different groups of participants were common to all projects: researchers, content specialists and teachers. This was to be expected from RD&D projects. More surprising were the roles played by each of the participant groups. Teacher participation moved beyond the role of "consumers of research" typically attributed to them in the traditional RD&D model. More than half of the projects analyzed reported some sort of teacher involvement in curriculum design, either reactively (e.g., by providing feedback after appraising prototypes of the educational solution) or proactively (e.g., by specifying their needs or translating the curriculum framework developed by researchers into concrete lesson plans). This indicates the presence of extended forms of communication between researchers and teachers throughout the RD&D process. While in the traditional RD&D model, communication was mainly characterized as being unidirectional and as primarily taking place at the diffusion phase of the RD&D process, the projects studied show a tendency towards increased communication and (in some cases) collaboration between teachers and researchers from the early stages of the RD&D process onwards.

Researchers also adopted multiple roles. They were actively involved in the design of the curriculum innovations and were also responsible for assessing its quality, utility, feasibility and/or effectiveness in natural settings. In addition, in a couple of projects researchers were even involved in diffusion activities, adopting the role of teacher trainers or facilitators during (pilot) implementation. Hence, their responsibilities went far beyond carrying out the R in RD&D. Similarly, content specialists' roles ranged from contributing with their knowledge and expertise during the curriculum design process, to providing professional advice during (pilot) implementation, to assisting researchers with data collection. This multiplicity of roles and activities reveals that, in contrast to the rather clear division of tasks suggested in the traditional RD&D model, in the projects studied both the researchers and the content specialists have been actively involved across multiple phases. Further research could contribute to exploring how consistently this expanded role of researchers is observed, and how it contributes to strengthened research and practice relationships.

As mentioned at the start of this chapter, the RD&D model and related evidence-based practices have long been strongly criticized for adopting a "teacher proof" approach (Biesta, 2010; Gottschalk et al., 1981; Posner, 2004; Schumacher, 1972). In contrast, the projects examined in this study actively involved teachers (e.g., teachers were invited to participate in the development team or in revision subcommittees); built in mechanisms for making site-specific modifications (e.g., data collected during formative evaluations was used to tailor the characteristics of the curriculum innovation to the needs, expectations, and background of potential users); and, assuming that adoption would be challenging, worked to render the innovations appealing and practical (e.g., teachers were provided with the opportunity to see how the curriculum innovation could be used in their classroom through demonstrations or teacher participation in communities of practice). Previous researchers have called for a modified RD&D model that emphasizes the organizational and individual factors influencing implementation (Gottschalk et al., 1981), one that is grounded in a rigorous and systematic use of scientific research and evaluation methods, but also actively encourages involvement of practitioners in the design process (Blakely et al., 1987). Our study shows that the projects analyzed do exhibit these principles.

We see a need to disentangle the criticism of the RD&D model from personal views concerning the goals and nature of research, the kinds of knowledge worth pursuing, and the acceptable methods for conducting scientific inquiry. Despite large epistemological differences between various approaches for bridging the research and practice gap, there seems to be increasing consensus about the need to intensify communication and collaboration among teachers, researchers and other stakeholders from the educational system (de Vries & Pieters, 2007; Levin, 2013; Lieberman, 1992; Penuel et al., 2015). Our findings reveal that projects based on the modified RD&D approach consider the needs of teachers and schools and involve them in the design process, although to different extents. This is a meaningful step forward in enabling new forms of communication between teachers and researchers. However, it should also be mentioned that most of the time, teachers' roles in the design process are still rather instrumental, insofar they are mainly considered in order to ensure successful implementation and "buy-in". We strongly encourage teacher involvement that extends to both knowledge use and knowledge production through active participation in research and design activities, as suggested by the teacher research (cf. Cochran-Smith & Lytle, 1999) and design research (cf. McKenney & Reeves, 2012) movements. Teacher adaptation of evidence-based practices would prevent the educational system from unwarranted expectations about the role of evidence in their practices and its uncritical use (Biesta, 2007, 2010).

Although the limited number of projects included in our study prevents us from making generalizations, the findings of the current study contribute a fresh look at the classic RD&D model. Alongside the work of others (cf. Gottschalk et al., 1981), this study can inspire novel ways of thinking about core RD&D assumptions, including: how to facilitate more active use of scientific research to inform curriculum development; the different ways the interactions between research, development and diffusion may be shaped; increased attention to the context; and new models of diffusion. Additionally, it can pave new paths for knowledge mobilization to let the educational system and particularly teachers benefit from the evidence produced by educational research (Levin, 2011). Yet, criticism of the RD&D model is not without reason. Based on our study, we suggest that the problem lies not in the RD&D model as a basic mechanism, but in narrow or outdated conceptualizations of the core processes (research, development and diffusion) and their interactions. This study provides both general findings and specific examples to spark discussions on what those processes can entail in fruitful RD&D.

Acknowledgements We gratefully acknowledge the Netherlands Organisation for Scientific Research (NWO) for funding this study (Project Number 411-08-601). The authors also thank Bart Ormel for his contribution to data collection and analysis.

References

Balram, S., & Dragicevic, S. (2008). Collaborative spaces for GIS-based multimedia cartography in blended environments. *Computers & Education, 50*(1), 371–385.

Bauer, K., & Fischer, F. (2007). The educational research-practice interface revisited: A scripting perspective. *Educational Research and Evaluation, 13*(3), 221–236.

Berger, U., Sowa, M., Bormann, B., Brix, C., & Strauss, B. (2008). Primary prevention of eating disorders: Characteristics of effective programmes and how to bring them to broader dissemination. *European Eating Disorders Review, 16*(3), 173–183.

Biesta, G. (2007). Bridging the gap between educational research and educational practice: The need for critical distance. *Educational Research and Evaluation, 13*(3), 295–301.

Biesta, G. (2010). Why 'what works' still won't work: From evidence-based education to value-based education. *Studies in Philosophy and Education, 29*, 491–503.

Blakely, C., Mayer, J., Gottschalk, R., Schmitt, N., Davidson, W., Roitman, D., et al. (1987). The fidelity-adaptation debate: Implications for the implementation of public sector social programs. *American Journal of Community Psychology, 15*(3), 253–268.
Broekkamp, H., & Van Hout-Wolters, B. (2007). The gap between educational research and practice: A literature review, symposium and questionnaire. *Educational Research and Evaluation, 13*, 203–220.
Burkhardt, H., & Schoenfeld, A. (2003). Improving educational research: Toward a more useful, more influential, and better-funded enterprise. *Educational Researcher, 32*(9), 3–14.
Carlson, J., Eisenmann, J., Pfeiffer, K., Jager, K., Sehnert, S., Yee, K., et al. (2008). (S)Partners for Heart Health: A school-based program for enhancing physical activity and nutrition to promote cardiovascular health in 5th grade students. *BMC Public Health, 8*, 1–12.
Clark, D., & Hopkins, J. (1969). *A report on educational research, development and diffusion manpower*. Bloomington, IN: Indiana University Research Foundation.
Cochran-Smith, M., & Lytle, S. (1999). Relationships of knowledge and practice. Teacher learning in communities. *Review of Research in Education, 24*, 249–305.
De Vries, B., & Pieters, J. (2007). Bridging the gap between research and practice: Exploring the role of knowledge communities in educational change. *European Educational Research Journal, 6*(4), 382–392.
Denzin, N., & Lincoln, Y. (Eds.). (2000). *Handbook of qualitative research* (2nd ed.). London: Sage Publications.
Farley-Ripple, E., May, H., Karpyn, A., Tilley, K., & McDonough, K. (2018). Rethinking connections between research and practice in education: A conceptual framework. *Educational Researcher, 47*(4), 235–245.
Fullan, M. (2007). *The new meaning of educational change*. London: Cassell Educational Limited.
Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.
Gottschalk, R., et al. (1981, October). *Multi-site implementation and replication of research findings. Is the modified RD&D model viable?* Paper presented at a meeting of the Evaluation Research Society, Austin, TX.
Hall, G., & Hord, S. (2010). *Implementing change: Patterns, principles and potholes*. Upper Saddle River, NJ: Prentice Hall.
Havelock, R. (1969). *Planning for innovation: A comparative study of the literature on the dissemination and utilization of scientific knowledge*. Ann Arbor, MI: Institute for Social Research, The University of Michigan.
Hemsley-Brown, J., & Sharp, C. (2003). The use of research to improve professional practice. A systematic review of the literature. *Oxford Review of Education, 29*, 449–471.
Jansen, W., Raat, H., Zwanenburg, E., Reuvers, I., van Walsem, R., & Brug, J. (2008). A school-based intervention to reduce overweight and inactivity in children aged 6-12 years: Study design of a randomized controlled trial. *BMC Public Health, 8*, 1–9.
Jurg, M., De Meij, J., Van Der Wal, M., & Koelen, M. (2008). Using health promotion outcomes in formative evaluation studies to predict success factors in interventions: An application to an intervention for promoting physical activity in Dutch children (JUMP-in). *Health Promotion International, 23*(3), 231–239.
Kennedy, M. (1997). The connection between research and practice. *Educational Researcher, 26*(7), 4–12.
Kittredge, D., Baldwin, C. D., Bar-On, M., Trimm, R. F., & Beach, P. S. (2009). One specialty's collaborative approach to competency-based curriculum development. *Academic Medicine, 84*(9), 1262–1268.
Landry, R., Amara, N., & Lamari, M. (2001). Climbing the ladder of research utilization: Evidence from social science research. *Science Communication, 22*(4), 396–422.
Levin, B. (2011). Mobilizing research knowledge in education. *London Review of Education, 9*(1), 15–26.

Levin, B. (2013). To know is not enough: Research knowledge and its use. *Review of Education, 1*(1), 2–31.
Lieberman, A. (1992). The meaning of scholarly activity and the building of community. *Educational Researcher, 21*(6), 5–12.
McIntyre, D. (2005). Bridging the gap between research and practice. *Cambridge Journal of Education, 35*(3), 357–382.
McKenney, S., & Reeves, T. (2012). *Conducting educational design research*. London: Routledge.
Mooij, T. (2008). Education and self-regulation of learning for gifted pupils: Systemic design and development. *Research Papers in Education, 23*(1), 1–19.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company*. Oxford, UK: Oxford University Press.
Nutley, S., Jung, T., & Walter, I. (2009). The many forms of research-informed practice: A framework for mapping diversity. *Cambridge Journal of Education, 38*(1), 53–71.
Nutley, S., Walter, I., & Davies, H. (2007). *Using evidence. How research can inform public services*. Bristol, UK: The Policy Press.
Penuel, W. R., Allen, A. R., Coburn, C. E., & Farrell, C. (2015). Conceptualizing research–practice partnerships as joint work at boundaries. *Journal of Education for Students Placed at Risk (JESPAR), 20*(1–2), 182–197.
Posner, G. (2004). *Analyzing the curriculum* (3rd ed.). New York: McGraw Hill.
Rogers, E. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
Schumacher, S. (1972, November). *Limitations of a research, development and diffusion strategy in diffusion: A case study of nine local implementations of state-adopted curriculum.* Paper presented at the National Council for the Social Studies Annual Meeting, Boston.
Stone, J., Alfeld, C., & Pearson, D. (2008). Rigor “and” relevance: Enhancing high school students’ math skills through career and technical education. *American Educational Research Journal, 45*(3), 767–795.
Thomas, G., & Pring, R. (2004). *Evidence-based practice in education*. Maidenhead, UK: Open University Press.
Vanderlinde, R., & van Braak, J. (2010). The gap between educational research and practice: Views of teachers, school leaders, intermediaries and researchers. *British Educational Research Journal, 36*, 299–316.
Williams, C., Carter, B., Kibbe, D., & Dennison, D. (2009). Increasing physical activity in preschool: A pilot study to evaluate animal trackers. *Journal of Nutrition Education and Behavior, 41*(1), 47–52.

Chapter 3
Teachers as Co-designers: Scientific and Colloquial Evidence on Teacher Professional Development and Curriculum Innovation

Hanna Westbroek, Bregje de Vries, Amber Walraven, Adam Handelzalts, and Susan McKenney

Introduction

Teacher participation in the collaborative design of curriculum materials is gaining momentum in educational practice. In collaborative design teams, teachers create new curricular materials such as courses or lessons in co-operation with each other, and often also with experts from the educational design, educational research, and educational content domains. Projects that involve collaborative design have different aims. At one end of the spectrum, professional development is seen as the primary aim. The production and enactment of curricular materials is considered more of a means and the designs are by-products. The lesson study approach (cf. Lewis, 2000) is a typical example of this. This increasingly popular professional development arrangement aims at gaining insight into the learning processes of students within a specific academic domain by co-designing one exemplar lesson in a cycle of design–enactment-evaluation–redesign.

H. Westbroek (✉) · B. de Vries
Free University of Amsterdam, Amsterdam, The Netherlands
e-mail: h.b.westbroek@vu.nl; b.de.vries@vu.nl;

A. Walraven
Radboud Teachers Academy, Radboud University, Nijmegen, The Netherlands
e-mail: a.walraven@docentenacademie.ru.nl

A. Handelzalts
Teacher Education Department, Free University, Amsterdam, The Netherlands
e-mail: a.handelzalts@vu.nl

S. McKenney
Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands
e-mail: susan.mckenney@utwente.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_3

At the other end of the spectrum, the emphasis is on curriculum innovation. Typical examples are the recent large-scale science curriculum reform projects in the Netherlands and Germany. These projects used collaborative design as an implementation-furthering strategy. A common premise is that collaborative curriculum design not only positively affects professional development but that this can result in a curriculum innovation as well (Fig. 3.1) (Borko, 2004; Koehler & Mishra, 2005).

Although the premises behind collaborative design are conceptually well-founded, their empirical base is less evident (Borko, 2004; Voogt et al., 2015). Therefore, and particularly in view of the increased attention to collaborative design in educational practice, the study presented here was undertaken to explore what empirical evidence is available about processes that take place when teachers co-design, how these contribute to professional and curriculum development, and what are fostering and hindering factors. Additionally, we searched for what has been reported about the possible effects on curriculum enactment.

Scientific, peer-reviewed articles were searched and analysed, using the following broad definition of collaborative design: at least two teachers who cooperatively (re)design curriculum materials with the aim of improving educational practice (Handelzalts, 2009). We additionally searched professional journals for colloquial evidence, for two reasons: to demonstrate that collaborative design is topical in practice as well, and to include more direct reports on teacher experiences. Colloquial evidence (cf. Wenger & Snyder, 2000) can be defined as descriptive and/or evaluative reports on design teams as portrayed in professional journals by teachers. The term 'colloquial evidence' stems from research on health care (cf. Lomas, Culyer, McCutcheon, McCauley, & Law, 2005). Such first-hand information on teacher experiences enabled us to compare teacher perspectives with researcher perspectives in an exploratory way.

Theoretical Background

The idea of involving teachers in collaborative curriculum design is, in an important sense, a reaction to traditional curriculum reform movements that have emerged over the past decades, as well as to the felt need that curriculum development needs to be more dynamic in response to a rapidly changing world. A curriculum is a plan for

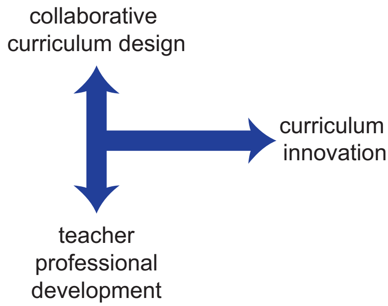


Fig. 3.1 Teachers who are involved in collaborative curriculum design experience professional development. The premise is that these two processes strengthen each other and can lead to curriculum innovation

learning (Taba, 1962). A curriculum is made manifest through various curriculum materials that can be designed at different levels of representation: standards are often developed on a national level, while on a classroom level, teachers design learning experiences for their students: units, lessons, activities, tests. How a plan for learning plays out in terms of actual student experiences and learning outcomes is ultimately determined by the way the designs are enacted by the teacher (Remillard & Heck, 2014). Teacher collaborative design typically applies to the classroom level (Voogt et al., 2011).

Collaborative curriculum design can take many forms that exhibit roughly two different models of curriculum innovation. On the one hand, in school-based collaborative design settings in which teachers cooperate to set goals and improve their practice (Handelzalts, 2009), teachers are seen as active agents and initiators of change (Severance, Penuel, Sumner, & Leary, 2016; Voogt et al., 2015). How teachers fulfil their role of 'change agent' might range from being modest adapters to being innovative. On the other hand, other initiatives have used teacher design teams to translate reform proposals into lesson materials as an implementation-furthering strategy (e.g., Parchmann et al., 2006). This approach does not fundamentally change the basic model of traditional curriculum reform. In this model, curriculum reform is initiated by 'others'. Instead of being a change agent, the teacher is the end-user who needs to 'fix' deficiencies in knowledge and beliefs, in order to properly understand and adopt the proposed curriculum reform and design and enact lesson materials accordingly. The impact of such traditional curriculum innovation initiatives has been poor: there is ample evidence that transformation of the intended design processes into classroom practice involves adaptation more often than not, and in most cases has resulted in a loss (slippage) of the initial innovative ideals (e.g., Remillard, 2005; Westbroek, Janssen, & Doyle, 2016). It is assumed that involving teachers at an early stage of curriculum reform at least narrows the gap between the initial intentions and enactment, because greater ownership is fostered and collaborative design can anticipate the types of adaptations teachers might likely make (e.g., Doyle & Ponder, 1977; Handelzalts, 2009).

Involving teachers in co-designing curricular materials is additionally assumed to comply with various features of effective teacher professional development. The design process itself is considered to require distinctive types of 'design practices' in moving from a conceptual idea to a product (cf. Naidu, Anderson, & Riddle, 2000). The process of collaborative design thus involves recursive (re)consideration, making design decisions based on articulated expectations and observing how the design actually functions in the classroom. If a new teaching approach is integrated into the curriculum materials, areas of difficulty may emerge that can be collaboratively discussed in the design team. Thus, collaborative design is geared toward actual practice: design, enactment and evaluation of artefacts based on insights into how to guide students' thinking and how to use these artefacts in practice (Borko, 2004; Van Veen, Zwart, Meirink, & Verloop. 2010). Furthermore, collaborative design is social in nature. It provides opportunities for collaboration with peers and experts which, in turn, can create opportunities for reflection on new teaching experiences (Borko, 2004; Lumpe, 2007; Voogt et al., 2011). A review of 82 studies showed that teachers who learn collaboratively tend to use more innovative pedagogies, better align written and enacted curricula, increase professional communication and display more job satisfaction and self-efficacy (Van Grieken, Dochy, Raes, & Kyndt, 2015).

In sum, we can conclude that there is sufficient theoretical basis for collaborative design. However, its empirical base is less solid. Therefore, in this study we address the following question: *From the perspectives of practitioners and researchers, respectively, what do empirical studies say about the processes of collaborative design and their effects on teacher professional development, curriculum development, and curriculum enactment?*

In this study we included colloquial evidence derived from professional papers to demonstrate that collaborative design is topical in educational practice, and to include teachers' perspectives in our analysis. The colloquial corpus reveals problems, experiences and results that teachers consider worthwhile to share with their colleagues, not being directed by a research agenda. Including colloquial evidence provides a unique picture of, in this case, Dutch teachers participating in collaborative design, and subsequently enabled us to identify what might be blind spots in the scientific corpus.

Method

Peer-reviewed articles published between 1988 and 2009 were included in this study. Initial systematic searches in three major databases, Scopus, Web of Science, and Eric, yielded 492 articles. A combination of the following search terms was used: teacher; different synonyms of curriculum design/innovation/or material development or teacher developed materials/teaching materials/lesson materials; different synonyms of collaboration/participation. The results from all databases were combined and controlled for overlap.

Additionally, 25 popular and well-used Dutch professional journals that address general and domain-specific pedagogical and instructional topics were selected. Because electronic indexing is not yet common for these sources, Dutch journals from only 1 year of publication (2008) were hand-searched. For those journals publishing fewer than four times annually, issues from 2007 were also included. We consider this study as a first step in including a colloquial body of evidence in a scientific literature review in order to examine and compare practitioners' perspectives and researchers' perspectives on the topic of collaborative curriculum design.

Both the scientific and professional articles had to meet the following criteria to be included in this study:

1. activities described involve at least two teachers co-designing;
2. activities described cover (part of) a design cycle: problem analysis, design, enactment, evaluation and redesign;
3. activities described contribute to the realization of a curricular product, such as national syllabi, learning materials.

This chapter reports on the collection and interpretation of data or – in case of the professional articles–experiences. Theoretical articles were excluded from the study. Professional articles that concerned a scientific study presented by researchers were also excluded. In the first screening, the abstracts of the scientific articles ($n = 492$) were independently examined by three researchers for meeting the inclusion criteria. Differences in judgment were discussed until agreement was reached. The inter-screener reliability was considered sufficient (Cohen's kappas: 0.64, 0.67 and 0.68). Based on this screening, 319 articles were labelled as not-relevant, 173 as relevant. Next, the full-text articles were screened. The level of agreement between two researchers ranged from substantial (Cohen's kappas of 0.68 and 0.77) to quite strong (0.86). Based on the full-text screening, another 144 articles were labelled as not-relevant, 29 as relevant. Not-relevant included being theoretically rather than empirically oriented. A substantial number of articles also only presented summative evaluations of the design products instead of scientific reports on the process of collaborative design. The scientific articles were additionally judged on specific quality criteria, such as consistency and presence of appropriate measurements to secure validity (cf. Campbell et al., 2003). Sixteen articles were considered of 'insufficient' quality, and were therefore excluded from the study. Of the remaining 13 articles, 9 concerned in-service teachers and formed the basis for this study (Table 3.1). Four articles concerned collaborative design by pre-service teachers and were excluded from the review.

The professional journals ($n = 25$) were hand-searched on (sub)titles and abstracts of articles that seemed to follow the inclusion criteria. This resulted in a data set of 35 articles. Next, two researchers independently screened the articles. Most (23) of the 35 articles did not meet the criteria. In many cases, the articles concerned a scientific study presented by researchers. The researchers reached a 100% consensus on which articles to include after short discussions of the relevant articles. The final data set contained 12 articles for further analysis (Table 3.1).

Table 3.1 Overview of the selected scientific and professional papers

Scientific papers	Professional papers
Baildon and Damico (2008)	Baack (2008)
Deketelaere and Kelchtermans (1996)	Boerstoel and Wielaard (2008)
Fernandez (2005)	Dijkstra (2008)
George and Lubben (2002)	Heijn and Krüger (2008)
Parchmann et al. (2006)	Hoekzema (2008)
Rock and Wilson (2005)	Hollaardt (2007)
Schneider and Pickett (2006)	Koelemij and Visscher-Meijman (2007)
Shkedi (1996)	Oosterling (2008)
Voogt, Almekinders, Van den Akker, and Moonen (2005)	Van den Broek (2007)
	Van der Westen (2008a)
	Van der Westen (2008b)
	Visser (2008)

Both the professional and scientific articles were analysed with the following questions:

1. What are the main characteristics of the design teams and the design processes?
2. What effects on teachers' professional development are reported?
3. What effects on curriculum enactment are reported?

Cross-article analyses were carried out to identify themes and patterns, dominant characteristics, processes, and effects of collaborative design (cf. Campbell et al., 2003; Noblit & Hare, 1988). The results of both the scientific and the colloquial cross-article analyses were discussed by the entire research team.

Results: The Colloquial Corpus

The selected articles were written by teachers ($n = 5$) or intermediaries from consultancy offices ($n = 7$). Ten articles concerned secondary education, two concerned primary education. The products designed varied from a small series of lessons to new instructional approaches such as collaborative and inquiry learning. Table 3.2 presents brief summaries of the projects.

Characteristics of the Design Teams

The design teams were either: (a) local and working in the same school ($n = 5$), or (b) regional/national with members from different schools ($n = 7$). On average, teams had about ten members. At primary schools, design teams encompassed the whole school team; at secondary schools, domain-specific departments usually formed the natural boundaries of the team. The teams either dealt with curriculum renewal by adopting new pedagogies and classroom organizations ($n = 4$) or with improvement of domain-specific lesson materials ($n = 8$). These domains varied from science to the languages and art. The vast majority of teams also had external members who helped coordinate the teams and inspired members with procedures and/or new content ($n = 9$). These external members came from general pedagogical institutes or domain-specific learning centres/university departments. Overall, the general picture in the colloquial corpus was a rather large multidisciplinary team of teachers and intermediaries/researchers from the educational field, in which teachers outnumbered external experts.

Table 3.2 Summaries of the professional projects

Study	Summary of the project
Baack (2008)	A team of eight foreign language teachers at one secondary school designed and implemented a new form to assess students' fluency during 1 year. Two prototypes were designed and tested. The teachers shared their experiences and the students' results. The teacher design team reported a more objective scoring procedure, and more explicit criteria for both the teachers and students, and higher foreign language fluency was noticed
Boerstoel and Wielaard (2008)	A team of members from five secondary schools designed and implemented a project-based curriculum with students engaged in self-regulated learning and teachers as coaches. The teacher design team used a design model that was developed and tested in the US. The new curriculum was evaluated through interviews with teachers and students, students' journals of students and classroom observations. Anecdotal proof from teachers and students was provided to illustrate positive outcomes such as new learning results and a quiet learning environment
Dijkstra (2008)	A team of members from five primary schools designed an adaptive curriculum for mathematics and language learning that aimed to divide students into either a pre-vocational or pre-scientific route. The teacher design team hoped to improve the students' learning process and give children more opportunities to experience success. The project ran for 3 years and was supported by an institute specializing in supporting weak students. The teacher design team reported positive effects on their own professional development as far as realizing adaptive teaching. The main curricular effect that was reported concerned an adjustment of end levels in the upper grades of the primary schools
Heijn and Krüger (2008)	Teachers from many different secondary schools supported by domain experts from universities teamed up to design new lesson materials for an interdisciplinary science program. A nation-wide project group consisting of different stakeholders monitored the process of implementation. The article described several lesson materials that were designed. No user evaluations were reported
Hoekzema (2008)	A team of teachers from nine secondary schools, supported by university teachers, designed web quests that help their students make more effective choices of a profession and university course of study. The project ran for several years. Anecdotal proof based on observations and informal interviews was provided for the lessons' effectiveness, as students seemed to gain insight into what certain professions really encompass in practice, and what they like to do and are good at. The teachers reported they had learned more about their students' worries and motives
Hollaardt (2007)	A team of teachers from two secondary schools designed new lesson materials for a multidisciplinary science program. They were supported and monitored by a nation-wide project group. The lesson materials aimed at showing the relationship between the disciplines involved, and at supporting problem-based inquiry by students. The article reported positive findings concerning interdisciplinary collaboration by teachers during the design process, as they got to know each other's learning content and found new opportunities to become fine-tuned with each other's programs

(continued)

Table 3.2 (continued)

Study	Summary of the project
Koelemij and Visscher-Meijman (2007)	A team of teachers at one primary school implemented a teaching model designed by others. Supported by educational experts, the team translated the general model into a school-specific curriculum aiming at more self-regulated learning and enhanced classroom organisation. The project ran for 4 years. The team developed their classroom practices in a cycle of design, implementation and evaluation. The evaluation was based on videotaped classroom observations and team-wide coaching. The teachers also observed their own practice to collect learner experiences. Positive findings were reported for teachers and students, as well as teams
Oosterling (2008)	Five pre-service teachers designed and implemented new lesson materials for mathematics that were aimed at motivating students to apply mathematical rules to daily problems. The project ran for 2 years and was supported by domain experts from universities and educational counsellors. Positive learner evaluations, and the teachers' ownership and enthusiasm were illustrated with citations from interviews. Lesson materials were extensively described and visualised, with the aim of sharing new materials and teachers' experiences
Van den Broek (2007)	Teachers from one secondary school developed a new mathematics curriculum that aimed to actively engage learners in doing mathematics. The project was started in the early 1970s and continued up to date to keep the 'Wageningse method' current. Other teachers from other schools joined the teacher design team to add their new materials across the years
Van der Westen (2008a, 2008b)	A school-wide team of teachers from a secondary school designed and implemented a so-called 'vocabulary portfolio' in which students wrote down newly learned words and their meaning, to improve learners' fluency and level of speaking. The portfolio was used across subjects. Per subject department, smaller teacher design teams designed and implemented use of the portfolio within their lessons. Several students participated in the project by attending department meetings to monitor the proceedings. The projects ran for 3 years. The project was monitored by classroom observations and interviews. No results were presented yet
Visser (2008)	A team of English teachers from one secondary school designed and implemented an extra curriculum for students who need a more challenging program. The team was supported by educational experts. The project ran for 2 years. The team kept a journal of its proceedings during weekly meetings to share their findings with other foreign language teachers. Anecdotal evidence from learners was collected to prove positive findings related to motivation and outcomes. In addition, teachers experienced a shared vision of instruction and reported experiences that were also beneficial for their regular classes

Characteristics of the Design Process

Many of the articles started with describing the design problem that teachers observed in their practice. For instance, teachers noticed that their students were not motivated to do mathematics and started searching for new and more challenging ways of teaching. In one article (Hoekzema, 2008), the practice-based starter for redesign was put as follows:

> Many upper secondary school students do not seem to choose the right vocational study. Their chances for failure in the near future are huge, and many freshmen change their majors later on. A group of nine schools decided to do something about that. (p. 54)

The colloquial corpus was larded with strong affective statements about how the design problem is personally experienced, and with personal wishes for improvement, indicated by sentence starters such as ‘At *my* school....’, ‘*I* really would *like*...’, and ‘Like many of my colleagues *I noticed* with my students that they...’ [italics added]. Hence, what ultimately motivated teachers to re-design their context was not a new scientific insight on how to do things, but a deeply felt and experienced problem in their own teaching practice. This focus also determined how teachers evaluated success.

In addition to a personally felt need for redesigning, teachers mainly began by drawing upon their own expertise to improve their learning environments. In many cases, they also got input (knowledge, skills, procedural support, materials) from specialists in the field, such as design experts. They seemed to reach out to a lesser extent for new scientific insights provided by universities or scientific journals ($n = 1$).

The articles gave extensive descriptions of the designs produced by the design teams. The backgrounds and different parts of the designs were presented, and illustrated with pictures of the materials. Often, the design teams used several iterations of designing, implementing, and evaluating to reach their final products. However, these cyclic processes were not documented systematically.

Effects on Teachers’ Professional Development

The colloquial corpus suggested that participating in collaborative design had positive effects on teachers’ ownership of the curriculum they plan. The teachers strongly identified with the goal, activities and results, and their personal judgements played a crucial role in the claims they made. The articles indicated that collaborative articulation of a problem enhanced a teacher’s motivation to redesign his or her daily practice. All articles reported personal involvement of the teachers and an eagerness to actively contribute to change: “I really like collaborative designing. It is a good thing if teachers do this. We stand squarely in practice and have developed a strong sense of what is possible and what isn’t in the classroom” (Hollaardt, 2007, p. 17). This readiness was also apparent in the way design products and learning processes that sprang from the collaborative designing were presented: extensively, with pride and affective wordings, as illustrated by:

> We are very proud of what we have arrived at. The lesson series runs very well and seems to have been given a strong position in the school curriculum. We have worked with much enthusiasm, and have more new schools interested in it than we can handle. (Oosterling, 2008, p. 27)

A second effect that became apparent was that collaborative design positively contributed to personal and social growth: team building, a broadening of task perception and collaboration skills. Many articles reported that the school or department team developed a common language and school vision, which paved the way for improvement of design processes and products, for example:

> It has become much more normal to discuss problems with each other, and help each other find solutions. Observing lessons, watching videotapes of lessons, and visiting each others' classrooms stimulate this sharing of ideas and have become normal now. This strongly influences our school climate and stimulates continuing development in the school. (Koelemij & Visscher-Meijman, 2007, p. 34)

Some articles additionally reported increased understanding of and better collaboration with students ($n = 4$). During the process of designing and evaluating, students were asked to articulate their experiences and appreciations, or, in one case, were invited to help the teachers redesign their lessons. As a result, teachers gained insight into how students were thinking about their lesson.

> Well, what we found was that prevocational students are very relational, are smart, can work independently to a certain extent, work well with practice-oriented assignments and prefer short-term goals. They like to learn in realistic contexts, can be extrinsically motivated, and like to learn by doing. (Hoekzema, 2008, p. 55)

More specific areas in which the teachers felt they became more professional were also mentioned, indicating gains in PCK and general pedagogical knowledge, such as becoming more skilled in applying specific instructional approaches for specific topics, becoming better at bridging the gap between physics and chemistry topics, gaining insight into how to realize truly adaptive learner-centred learning environments, and improved fine-tuning between primary and secondary education in some domain.

Effects on Curriculum Enactment

Most of the articles provided information about how the materials worked in practice. Teachers as well as students were quoted to illustrate typical aspects of successes and failures of the designs, such as student motivation, learning outcomes, and essential learning processes that were observed. For the teachers, student motivation and learning outcomes were by far the most important measures of the design's success. The enactment of the designed product was mostly followed anecdotally. The articles were heavily laden with anecdotes and they cited both teacher and student experiences with the new materials.

Our colloquial data also included indications of positive effects of professional development on the quality and sustainability of curriculum innovation. First of all, some design teams involved all teachers from the school or the department, resulting in a school- or department-wide process of redesigning. The shared ownership and fine-tuning between each other's experiences, attitudes and visions seemed firm and continuous, and implied that the curriculum innovation had become embedded within the school's vision. Sustainable team-wide discussion and collaborative (re) design became more appropriate. For instance, one study concluded: "The curriculum innovation has not finished yet. But the interrelatedness between different renewal processes has become more clear to the teachers, and less than before, the teachers experience the innovations as 'again we must change' " (Koelemij & Visser-Meijman, 2007, p. 34). Another article said: "The design team has found some new young members. Together with 'the oldies' we seem to have reached a good mix to keep contributing to the mathematics curriculum of the future" (Van den Broek, 2007, p. 19). Furthermore, forming a design team opened the way to invite external participants. The input that came from domain experts and teacher colleagues from other schools seemed, in some cases, to result in a more structured design process, and opportunities to translate experiences from others to one's own school setting. For instance, one expert introduced video-stimulated recall to collaboratively observe the effects of a new instructional approach in the classroom. This helped members of the design team get a better grip on the effects on their curriculum, and hence made it easier to make further adjustments (Koelemij & Visser-Meijman, 2007).

Results: The Scientific Corpus

The scientific corpus showed that teacher design teams were not (yet) a major focus in empirical educational research. Nine small-scale studies and one large-scale study (Parchmann et al., 2006) were selected (Table 3.3). Similar to the professional articles, most studies (n = 8) pertained to primary and secondary education. The majority of the teams aimed to design a lesson series within the domain of science, technology or mathematics. In most cases researchers and/or intermediates from consultancy offices took the initiative (n = 7).

Characteristics of the Design Teams

Similar to the colloquial corpus, the scientific corpus pertained to design teams that were either school-based (n = 5), or regionally/nationally organized, having members from different schools (n = 4). The size of the teams varied from 2 up to 18 participants. A notable difference with the colloquial corpus was that the initiative for the project was mostly taken by others than the teachers (n = 6, 1 unclear). Teachers often had the role of learners, while researchers took the role of facilitator of the design processes. The image that emerged from these studies was that researchers and teachers tended to differ in aims and orientations, revealed by application of different criteria for assessing quality of processes and products. Some studies approached these discrepancies as differences in aims and orientations

Table 3.3 Summaries of the scientific projects

Study	Summary of the project
Baildon and Damico (2008)	A team of six humanities teachers at an American international school in Singapore refined and tested a tool for literacy and inquiry lessons during 1 year. The initial tool was developed by one of the participating teachers. The common aim of the group was to improve their inquiry lessons and develop a broad view on inquiry
Deketelaere and Kelchtermans (1996)	A team of 17 Belgian teachers from different subject areas and an educational researcher co-designed two modules from scratch that aimed at 'breaking through gender roles and interesting girls in technology'. The researcher was initiator, guide and keeper of the process that covered problem analysis activities, design, try-out and evaluation/reflection activities over a 2-year time span
Fernandez (2005)	A team of four U.S. elementary teachers engaged in mathematics lesson study for 3 months. Teachers received schooling in the lesson study approach, after which they adapted an exemplary lesson on 'helping students see why fractions are needed to solve certain problems of sharing'. The researcher, who was initiator of the project, only interfered at the teachers' request
George and Lubben (2002)	Two teams of ten teachers from Trinidad and Tobago were selected for a 4-day workshop on learning to design context-based science education. The researchers led the workshop. After initial problem analysis, teachers co-designed context-based science lessons that were then evaluated by experts
Parchmann et al. (2006)	Teacher design teams (about ten participants each) were formed in Germany to design and implement context-based chemistry education according to a framework, over a 2-year timespan. Chemistry education researchers developed the framework in co-operation with 37 teachers. Chemistry education researchers guided the teams, providing them with the framework and exemplary materials
Rock and Wilson (2005)	Two teams of four elementary teachers in the U.S. each engaged in lesson study. The teams aimed at developing a teaching repertoire for differentiation in mathematics education and literacy, respectively. After initial training in the lesson study approach, teachers determined how to carry out the lesson study and what to talk about. Researchers only gave advice when asked
Schneider and Pickett (2006)	An engineer who taught at a university and a science teacher educator co-developed an engineering course for science education students (to be taught by the engineer) that was to be innovative in many ways *and* needed to meet the curriculum standards. One teacher taught the course. Evaluation findings were analysed and reported. The project took place in the U.S. over a period of 8 months
Shkedi (1996)	Eight teachers at a Jewish school in the U.S. participated in a 6-month school-based workshop that aimed at developing curriculum materials for teaching Jewish moral texts. The teachers discussed the materials and how they should be adapted for their teaching, under the guidance of a workshop leader
Voogt et al. (2005) -2nd study	The second study featured eight Russian physics teachers participating in workshops led by the researchers. The workshops aimed to support teachers with the implementation of technology-rich learner-centred approaches to learning physics, over a total timespan of 15 months. Teachers received training in basic technology skills and applications in physics and were introduced to learning centred approaches; based on problem analysis, they each designed teaching materials and shared their experiences with each other via a website

between researchers/intermediaries and teachers (cf. Deketelaere & Kelchtermans, 1996; Parchmann et al., 2006). In other studies, such discrepancies were taken to signify a lack of understanding on the teachers' part (George & Lubben, 2002).

Overall, the scientific corpus tended to emphasize the importance of a theoretical orientation and the need to think back and forth between classroom activities and design frameworks. The different orientations of researchers and teachers seemed to be more emotionally charged and problematic when the role of the teacher was less explicitly 'the learner' and more the equally equipped co-designer (Deketelaere & Kelchtermans, 1996).

Characteristics of the Design Process

In contrast to the colloquial corpus, the scientific data set gave far more detailed descriptions of the design and interaction processes in the teams. However, process characteristics were rarely if at all related to teacher development or curriculum enactment.

The design processes that emerged from the scientific data set differed distinctly from what was described by the colloquial corpus. First of all, none of the studies used teachers' motives to justify the project, except for Baildon and Damico (2008). Instead, arguments were used that encompassed evidence on what counts as good education and effective professional development. Secondly, all studies, except Schneider and Pickett (2006), emphasized the importance of different types of support for the process. None of the studies systematically analysed which support was effective in what way, however. Some types of support were mentioned by teachers when asked what they considered as helpful in the process (e.g., George & Lubben, 2002; Parchmann et al., 2006; Rock & Wilson, 2005). Some types were discussed by the researchers when reflecting on the process and findings (e.g., Baildon & Damico, 2008; Deketelaere & Kelchtermans, 1996; Fernandez, 2005; George & Lubben, 2002; Shkedi, 1996; Voogt et al., 2005). Across the studies, roughly three types of support emerged: pre-structuring of design activities; monitoring and directing discussions; and input of external expertise.

Thirdly, design activities were described as being highly pre-structured and explicitly planned. In systematic curriculum design, processes were typically iterative: problem analysis, design, enactment and evaluation, reflection, re-design and so on. All the studies were conducted within the conceptual framework of systematic curriculum design, although not all design teams went through the whole process, due to limited time and resources, and some studies only focused on one aspect of the design process in more detail, leaving it unclear precisely what other activities were performed. Two studies concerned 'lesson studies' (Fernandez, 2005; Rock & Wilson, 2005). In most cases, the lesson studies aimed at gaining insight into the learning processes of students within a specific domain by co-designing one lesson. The lesson was generally optimized in successive pre-structured cycles of enactment, evaluation, reflection and re-design. These teams were almost always guided by a domain and lesson study expert.

Fourth, in most studies (*n* = 6), the team was guided by someone who led the discussions, varying from a more procedural role (moderator) to a more directive role of instructor. When comparing different studies, it seemed that the less the process was actively directed and fed by an instructor, the more the boundaries of the innovation were determined by the boundaries of teacher knowledge, nicely illustrated in the articles by Shkedi (1996) and Deketelaere and Kelchtermans (1996). These studies elaborated on the types of discussions that emerged under the guidance of a workshop leader (Shkedi, 1996) and a member of the Flemish educational council (Deketelaere & Kelchtermans, 1996). Whereas the workshop leader tended to let discussions emerge from the concerns of the teachers and focused primarily on making sure that everyone had a say, the member of the Flemish educational council played an important directive role in creating a shared platform and directing discussions beyond the teachers' practical concerns to a more abstract level. In this latter study (Deketelaere & Kelchtermans, 1996), the participating teachers broadened their task perception and they became aware of the subjective and contextualised nature of their interpretive framework. In contrast, Shkedi (1996) concluded that discussions did not rise beyond the dilemmas that the teachers raised.

As in the colloquial corpus, external input provided support to teams: exemplary curriculum materials and explicit knowledge/skills. However, none of the articles reported a systematic study on the impact of external knowledge on the quality of processes and products. In several studies (*n* = 7), exemplary curriculum materials served as a means for stirring up discussions, explicating understandings (Baildon & Damico, 2008; Fernandez, 2005; George & Lubben, 2002; Shkedi, 1996; Voogt et al., 2005) and creating a shared vision (Deketelaere & Kelchtermans, 1996). Parchmann et al. (2006) mentioned that teachers indicated that they experienced exemplary materials as fostering the design process. In a few studies (*n* = 4), teachers were trained before they started designing. For example, in the studies by George and Lubben (2002) and Voogt et al. (2005), teachers participated in workshops on teaching approaches they were to implement in their designs; similarly, in the research by Fernandez (2005) and Rock and Wilson (2005), teachers were prepared for the lesson-study approach. In the research reported by Rock and Wilson (2005), teachers additionally invited experts to provide workshops in the areas they wanted to focus their lesson study on. They experienced the external input from experts as very beneficial to the process and related it directly to the problem being studied, which indicated active use of external knowledge. These findings strengthen the idea that fine-tuning the input of external knowledge and expertise to the needs of teachers is important.

Effects on Teachers' Professional Development

Most studies ($n = 8$) analysed the effects on professional development and measured a modest positive learning effect. Negative effects were also reported ($n = 3$). The effects on professional development differed in terms of content, width and depth both across and within studies. Several studies ($n = 4$) reported that teachers experienced some sort of professional growth in terms of broadened task perception, increased job satisfaction and/or feelings of empowerment and professional confidence.

Measurements of gains in knowledge were either rather fragmented and domain-specific or very general and elusive ('teachers felt they learned a lot'). The *quality* of the knowledge developed seemed especially difficult to capture. Precise conceptual definitions of teacher knowledge and teacher learning were generally lacking (cf Van Veen et al., 2010), as were logical operational definitions of such conceptualisations as measurable indicators (cf. Abell, 2008). General findings such as, "The teaching materials enhanced dialogue between the teachers that resulted in re-conceptualizing the nature of inquiry, re-considering their perspectives on subject matter understanding and in developing new views on the nature of end products" (Baildon & Damico, 2008), typically revealed meanings perceived differently at a more detailed level by each participant. Teachers developed different views of what constituted appropriate student end products.

Effects on Curriculum Enactment

Characteristics of actual curriculum enactment were only partially presented in some studies as indicators of teacher development (previous section). Only in Parchmann et al. (2006) was enactment measured by means of interviews and teacher questionnaires. In this project, collaborative design was used as an implementation furthering strategy. Many design teams were established to scale-up the innovation. The interviews and questionnaires revealed that not all design principles were equally implemented. Teachers used real-life contexts and developed student-oriented teaching methods, but they implemented the idea of developing concepts from the real-life contexts to a far lesser extent. Teachers feared that students would not learn appropriate subject- matter content well enough when contexts were used as a guideline for introducing concepts (Parchmann et al., 2006).

Conclusion

Two distinct pictures of design teams emerge from the two data sets (summarized in Table 3.4).

In the scientific corpus, projects aimed at developing curriculum materials using a conceptual framework that envisioned a new teaching approach. Teachers generally did not initiate the projects. Ironically, design teams were mostly viewed as a bottom-up strategy for essentially top-down innovations. Much attention was paid to the design process. Reported effects on teacher development were either general and elusive or fragmented. Quality and enactment of the new curricula were not studied systematically. Two related themes emerged that seem to point to possible critical factors:

- The roles that participants take. In most cases, teachers are explicitly learners.
- The extent to which teams are supported and directed. Directive external support for teachers seems needed to broaden their personal perspective.

In the colloquial corpus, teachers took the initiative for projects, addressing what they felt as acute, always concrete, problems. Teachers' feeling of ownership over the designs was greatly emphasized. Teams worked iteratively, although – so it seemed - unsystematically. Therefore, it was difficult to attribute effects to specific process characteristics. Effects on curriculum reform and professional development were highly visible in reported learning and motivational effects for students, and team and vision development effects amongst teachers.

Table 3.4 Summary of scientific and colloquial data sets

	Colloquial corpus	Scientific corpus
Team characteristics	Teacher-led	Researcher-led
	Teachers as experts	Teachers as learners
Process characteristics	Concern-driven	Theory-driven
	Cyclical	Systematic
	Incidental external input	Structural external support
Effects on teacher development	Experienced relevancy leading to ownership	Perceived relevancy leading to active involvement
	Team building	Elusive or fragmented and specific learning yields
Effects on curriculum enactment and attainment	From an ideal to an attained curriculum	From an ideal to a perceived curriculum

Discussion

New insights and societal developments continually ask for new, ambitious teaching practices. How to foster educational change through curriculum innovation has been a long-standing question within the worlds of educational research and innovation. It is rather commonly accepted nowadays that large-scale top-down approaches have little impact. Hence, the need arises to engage teachers as co-designers of new curricular materials in collaborative design settings (Handelzalts, 2009; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). In this study we explored the scientific and colloquial evidence in order to gain insight into the conditions under which such teacher design teams are effective. We looked at the perspectives of researchers (scientific evidence) and of teachers (colloquial evidence) regarding what those conditions might look like. Obviously, the yield of relevant scientific articles was low. This might be due to publication bias. For this particular study, we were interested in empirical studies that examined processes. Such studies tend to be qualitative and complex and are generally more difficult to publish than quantitative effect studies. Furthermore, this study is unique in including colloquial reports. In order to draw conclusions about the added value of including colloquial evidence, we need to consider the differences between the data sets. First, there is an asymmetry of period and place for the two corpora of reports that is difficult to avoid due to practical reasons, as we pointed out previously. We think, however, that as there is no research agenda that directed responses, the colloquial corpus provides an unbiased picture of experiences of (in this case, Dutch) teachers participating in design teams within a certain time-span.

With the above in mind, roughly two different images emerged that seem to pertain to two models of curriculum change: teachers as learners who need to develop their knowledge and beliefs in order to adopt the change proposals of 'others' (mainly scientific evidence) and teachers as initiators and active agents of change (mainly colloquial evidence). The gap between change proposals and the competencies needed to implement the change proposals adequately (e.g., Kirschner, 2015), and actual teaching practices and teacher competencies is explicitly problematized. How teachers design their practices, what their goals are and what they are passionate or worried about, is mostly underexposed as a starting point for change. This 'gap' is not addressed as a problem in the colloquial evidence at all. However, in the colloquial corpus the conceptual foundations of the change are to some degree left unarticulated, as well as how the quality of the design process and the designs were preserved. The question that emerges is: did the scientific evidence and the colloquial evidence report on the same phenomena, but merely express different perspectives on what was important? Or did they actually report on teacher design teams that operated under different conditions? It seems prudent to pursue answers to questions such as these in subsequent research. Meanwhile, we conclude that although design teamwork is gaining momentum in practice, the research base from which guidance can be gleaned to inform future work needs to be strengthened.

References

Abell, S. K. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education, 30*, 1405–1416.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*, 3–15.

Campbell, R., Pound, P., Pope, C., Britten, N., Pill, R., Morgan, M., et al. (2003). Evaluating meta-ethnography: A synthesis of qualitative research on lay experiences of diabetes and diabetes care. *Social Science and Medicine, 56*, 671–684.

Doyle, W., & Ponder, G. (1977). The practicality ethic in teacher decision-making. *Interchange, 8*, 1–12.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams*. Unpublished doctoral dissertation. Enschede, The Netherlands: University of Twente.

Kirschner, P. A. (2015). Do we need teachers as designers of technology enhanced learning? *Instructional Science, 43*(2), 309–322.

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education, 21*(3), 94–102.

Lewis, C. (2000). *Lesson study: A handbook for teacher-led improvement of instruction*. Philadelphia: Research for Better Schools.

Lomas, J., Culyer, T., McCutcheon, C., McCauley, L., & Law, S. (2005). *Conceptualizing and combining evidence for health system guidance*. Ottawa, Canada: Canadian Health Services Research Foundation.

Lumpe, A. T. (2007). Research-based professional development: Teachers engaged in professional learning communities. *Journal of Science Teacher Education, 18*, 125–128.

Naidu, S., Anderson, J., & Riddle, M. (2000). The virtual print exhibition: A case of learning by designing. In R. Sims, M. O'Reilly, & S. Sawkins (Eds.), *Learning to choose: Choosing to learn (Short papers and works in progress)* (pp. 109–114). Lismore, Australia: Southern Cross University Press.

Noblit, G. W., & Hare, R. D. (1988). *Meta-ethnography: Synthesizing qualitative studies*. London: Sage Publications.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Remillard, J. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*, 211–246.

Remillard, J. T., & Heck, D. J. (2014). Conceptualizing the curriculum enactment process in mathematics education. *ZDM Mathematics Education, 46*, 705–718. https://doi.org/10.1007/s11858-014-0600-4.

Severance, S., Penuel, W. R., Sumner, T., & Leary, H. (2016). Organizing for teacher agency in curricular co-design. *Journal of the Learning Sciences, 25*(4), 531–564.

Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt, Brace & World.

Van Grieken, K., Dochy, F., Raes, E., & Kyndt, E. (2015). Teacher collaboration: A systematic review. *Educational Research Review, 15*, 17–40.

Van Veen, K., Zwart, R., Meirink, J., & Verloop, N. (2010). *Professionele ontwikkeling van leraren: Een reviewstudie (Professional development of teachers: A review study)*. Leiden, The Netherlands: ICLON.

Voogt, J. M., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. E. (2015). Collaborative design as a form of professional development. *Instructional Science, 43*(2), 259–282. https://doi.org/10.1007/s11251-014-9340-7.

Voogt, J. M., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S. E., Pieters, J. M., & De Vries, B. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235–1244.
Wenger, E. C., & Snyder, W. M. (2000). Communities of practice: The organizational frontier. *Harvard Business Review, 78*, 139–145.
Westbroek, H. B., Janssen, F. J. J. M., & Doyle, W. (2016). Perfectly reasonable in a particle world: Chemistry responses to a change proposal. *Research in Science Education, 46*, 1–21.

References of the Studies Included in the Review

Professional Papers

Baack, J. (2008). Praktische beoordelingsformulieren spreekvaardigheid. *Levende Talen Magazine, 8*, 13–16.
Boerstoel, F., & Wielaard, C. (2008). Dutch big picture van start. *Bij de les, 3*, 17–19.
Dijkstra, I. (2008). Gedifferentieerd onderwijs werkt: Oplossing voor leerling die groep 8 echt niet redt. *Didaktief, 1–2*, 46–48.
Heijn, J., & Kruger, J. (2008). Wiskunde in NLT. *Nieuwe Wiskrant, 1*, 10–14.
Hoekzema, J. (2008). Kiezen & kunnen: Dubbelvla op het Arentheem College. *Bij de les, 1*, 54–55.
Hollaardt, B. (2007). NLT: Een nieuw betavak dat grenzen overschrijdt. *Vernieuwing, 66*, 16–17.
Koelemij, G. J. E., & Visscher-Meijman, M. E. (2007). Invoering van het GIP-model op ZMLK-school de Ark. *Tijdschrift voor Orthopedagogiek, 46*, 27–37.
Oosterling, N. (2008). DisWis: Weer eens wat anders dan alleen afgeleiden en primitiveren. *Nieuwe Wiskrant, 28*, 24–28.
Van den Broek, L. (2007). Idealistische wiskundeleraren geven lesboek in eigen beheer uit. *Vernieuwing, 2*, 17–19.
Van der Westen, W. (2008a). 'Elke docent voor taalrendement!': Taalbeleid op het Rijswijks Lyceum deel 1. *Levende Talen Magazine, 1*, 9–12.
Van der Westen, W. (2008b). 'Elke docent voor taalrendement!': Taalbeleid op het Rijswijks Lyceum deel 2. *Levende Talen Magazine, 3*, 13–15.
Visser, M. (2008). Fast Lane English: Versterkt Engels op het Stella Maris College Meerssen. *Levende Talen Magazine, 5*, 17–20.

Scientific Papers

Baildon, M., & Damico, J. (2008). Negotiating epistemological challenges in thinking and practice: A case study of a literacy and inquiry tool as a mediator of professional conversation. *Teaching and Teacher Education, 24*, 1645–1657.
Deketelaere, A., & Kelchtermans, G. (1996). Collaborative curriculum development: An encounter of different professional knowledge systems. *Teachers and Teaching: Theory and Practice, 2*, 71–85.
Fernandez, C. (2005). Lesson study: A means for elementary teachers to develop the knowledge of mathematics needed for reform-minded teaching? *Mathematical Thinking and Learning, 7*, 265–289.
George, J. M., & Lubben, F. (2002). Facilitating teachers' professional growth through their involvement in creating context-based materials in science. *International Journal of Educational Development, 22*, 659–672.

Parchmann, I., Grasel, P. I., Baer, A., Nentwig, P., Demuth, R., & Ralle, B. (2006). Chemie im Kontext – a symbiotic implementation of a context-based teaching and learning approach. *International Journal of Science Education, 28*, 1041–1062.

Rock, T. C., & Wilson, C. (2005). Improving teaching through lesson study. *Teacher Education Quarterly, 32*, 77–92.

Schneider, R., & Pickett, M. (2006). Bridging engineering and science teaching: A collaborative effort to design instruction for college students. *School Science and Mathematics, 106*, 259–266.

Shkedi, A. (1996). School-based workshops for teacher participation in curriculum development. *Journal of Curriculum Studies, 28*, 699–711.

Voogt, J. M., Almekinders, M., Van den Akker, J. J. H., & Moonen, B. (2005). A blended in-service arrangement for classroom technology integration: Impacts on teachers and students. *Computers in Human Behavior, 21*, 523–539.

Chapter 4
Teacher Design Teams for School-Wide Curriculum Development: Reflections on an Early Study

Adam Handelzalts, Nienke Nieveen, and Jan Van den Akker

Introduction

From a comparative European perspective, the Netherlands can be characterised as a nation with a highly decentralised curriculum policy (Kuiper, Van den Akker, Hooghoff, & Letschert, 2006; Nieveen & Kuiper, 2012; Nieveen, Van den Akker, & Resink, 2010). Ambitions for large-scale and 'top-down' curriculum reform have usually been modest and there is continual balancing between curriculum freedom and regulation (Kuiper, Nieveen, & Berkvens, 2013; Nieveen, Sluijsmans, & Van den Akker, 2014). Schools at the primary and junior secondary levels have much autonomy in deciding about their local curriculum. However, it often appears very challenging for schools and teachers to utilise that curriculum space fruitfully. The situation is somewhat different in senior secondary education where, over the last two decades, various efforts have been made for more centralised curriculum change. However, those efforts have resulted in rather overloaded and fragmented programs with limited implementation success.

The extent to which the goals and contents of (compulsory) education should be regulated has been a complicated balancing act. A recent review of curriculum trends in the Netherlands (SLO, 2015) concluded with various recommendations, including some that seem relevant for this context:

A. Handelzalts (✉)
Teacher Education Department, Free University, Amsterdam, The Netherlands
e-mail: a.handelzalts@vu.nl

N. Nieveen
ELAN Department of Teacher Development, University of Twente, Enschede, The Netherlands
e-mail: n.m.nieveen@utwente.nl

J. Van den Akker
University of Twente, Enschede, The Netherlands

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_4

1. There is a need for concise but clear curriculum frameworks that offer well-defined direction and space for schools and teachers, in combination with considerable investments into the curricular expertise of teachers and school leaders to strengthen their capacity for utilising the space productively for school-based curriculum development.
2. Those curriculum frameworks (for various subjects and sectors of schooling) need justification in a coherent, overarching vision of the main purposes of teaching and learning.

During 2016, a national dialogue was conducted to develop and discuss such an integral curriculum vision. Initial reactions to the resulting advisory report (see www.onsonderwijs2032.nl) made it clear that, not surprisingly, it will not be easy to reach consensus on a 'national' vision of the major aims and contents of learning. However, all reactions underlined the need to give teachers a stronger role in curriculum development, deciding upon their own curriculum preferences and options, in order to realise context-specific solutions that involve ownership and commitment at the school level. As there is also a growing awareness of the complexities and timeframe involved in introducing, realising and sustaining curriculum change, the learning processes of schools and teachers themselves have to come more to the forefront of curriculum improvement.

This current trend for school-based curriculum development makes it interesting to have a retrospective view, with reflection upon a study that was conducted in earlier days on the role of teacher design teams in the context of local curriculum renewal. In the next sections (the main part of this chapter) we will first report on this study, as was also done in a previous ECER paper (Nieveen, Handelzalts, Van den Akker, & Homminga, 2005). The study centred on the potentials of *teacher design teams* as a means to integrate curriculum development, teacher development and school organization development. Here, teacher collaboration was seen as essential to bridge the gap between the work of individual teachers (within their own subjects and classrooms) and school-wide aspirations. The chapter provides the rationale behind teacher design teams together with findings from the school site. In the last section we will reflect upon the findings, taking into account more recent trends in policy, practice and research since 2005.

Teacher Design Teams: A Scenario for School-Based Curriculum Renewal

The study that we report here was conducted in the period 2002–2004. At the time we viewed the long-range, collaborative activities of teachers, focusing on curriculum design and discourse within their own school context, as crucial for the kind of teacher learning that can have a profound impact on student learning (cf. Ball & Cohen, 1996; McLaughlin & Talbert, 2001; Shulman & Sherin, 2004). We referred to such teams of teachers who are involved in joint curriculum design efforts as Teacher Design Teams (TDTs). As this study was conducted as (probably) the first one in the field to use the label of TDTs, no sources were yet available that discussed the concept of TDTs. In this section, we present (by and large in our wordings from that time) the ideas, experiences and sources that assisted and inspired us when we were building our understanding of the rationale behind these teacher design teams. First, we will provide our main line of reasoning about why teacher collaboration in curriculum design is important for school-wide curriculum improvement. Then, we will elaborate on the phenomenon of teacher design teams itself and on suitable school conditions under which it may flourish.

School-Based Curriculum Development and Teacher Development

As changes in the curriculum (including its aims and objectives, subject matter, learner and teacher activities, resources, assessment procedures) have great potential to impact student experiences and performance, schools should focus on improving their school-wide curriculum when striving after school improvement (cf. Hopkins, 2001). This section elaborates on key roles of teachers and teacher collaboration in school-wide curriculum development.

Teachers as Learners and Designers

Teachers play crucial roles within the context of school-wide curriculum improvement. Consequently, several authors have convincingly recommended putting *teachers-as-learners* at the forefront of curriculum change (cf. Black & Atkin, 1996; Putnam & Borko, 2000). This was succinctly captured by Stenhouse (1975) in a well-known slogan: “No curriculum change without teacher change”. This type of teacher learning can be sorted into four categories (Kwakman, 2003): reading and observing (in order to collect new knowledge and information); experimenting (as an intentional effort by teachers to try something new within the classroom); reflecting (as a prerequisite for recognising and changing routine behaviour); and collaborating (to provide teachers with support for learning and feedback and to bring about new ideas and challenges). These categories are not exclusive and should preferably be combined in the process of professional development. Teacher learning is becoming more and more an on-going process and not as limited to a ‘one-shot’ workshop at an external location (Hargreaves, Earl, Moore, & Manning, 2001). In order to overcome transfer problems, teacher learning should be embedded in their daily practice. The integration of work and learning processes is therefore seen as a necessary condition for change and improvement at both the individual and organisational level (Kwakman, 2003).

In the meantime, *teachers-as-designers* in curriculum change efforts have been gaining attention as well, as the ‘enactment’ perspective on implementation (teachers and learners together create their own curriculum realities) seems more appropriate (cf. Snyder, Bolin, & Zumwalt, 1992) than the ‘fidelity’ perspective (teachers faithfully following curricular prescriptions from external sources). For that reason, teachers’ active involvement in rethinking and planning the new curriculum needs to be emphasised. According to Skilbeck (1998), there is a great need to encourage teachers to get involved more fully in such curriculum development processes. In contrast to organizational issues, the focus on improving the curriculum is intrinsically motivating to teachers. It is appealing to them to put effort into planning the actual learning processes of their students in their own subject-matter domain (cf. Black & Atkin, 1996; Grossman & Stodolsky, 1995). Additionally, Skilbeck (1998) argued that teacher participation in curriculum development will help improve the quality and relevance what is taught and will strengthen teacher professionalism.

Moreover, teachers’ participation in design processes and in implementing these designs in practice is crucial for teacher learning. When designing their future practice, teachers connect their current practice with their needs and wishes. By piloting the design and by reflecting on the experiences and results, teachers become aware of the specific potentials and problems of the new curriculum. Based on such systematic reflections they gain new insights for the (re)design. This can lead to yet another cycle of design, evaluation and reflection. This cyclical process is closely related to that of knowledge-of-practice advocated by Cochran-Smith and Lytle (1999), wherein teachers use their practice to construct knowledge and create change.

In conclusion, a reciprocal relationship between continual teacher development and cyclical curriculum development appears highly desirable. Learning by design, piloting and reflection are at the heart of this relationship.

Importance of Teacher Collaboration in Curriculum Development

Creating and implementing curriculum change is not an easy task, even for teacher advocates who appreciate and support the change. Many plans to innovate fail at an early stage, and when an attempt does succeed, it is often an isolated effort by one or two teachers. In the long run, most curriculum innovations and projects that rely on such individual teachers’ voluntary commitments do not last (Hargreaves, 2003). Part of the problem is that most teachers teach alone in isolated classes without having (or taking) the opportunity to reflect together on their teaching practices, bring in new perspectives, discuss new ideas, give each other feedback on improvement efforts, and jointly come to new initiatives.

In order to get out of their customary isolation, teachers need to collaborate. Little (1990) distinguished four types of such collegial collaboration based on the content of the interaction: story-telling, helping, sharing, and joint work. Although the first three types may assist in maintaining a certain level of workforce stability, they seem less likely to account for high rates of innovation and professional development. Therefore, Little (1990) suggested that schools that aim at innovation need teachers who work together on the curriculum renewal and who reflect on and learn from their experiences. Advocates of 'professional learning communities' have offered comparable arguments (e.g., Hord, 2004; Lieberman & Miller, 2004; McLaughlin & Talbert, 2001).

A more substantive argument for the importance of joint work can be offered alongside this strategic argument. Collaboration by teachers is indispensable for schools that are working towards a more effective curriculum by bringing greater relevance and coherence into the overall curriculum, such as by making meaningful connections between topics or skills that are usually addressed in different subject areas and/or over longer trajectories.

The Phenomenon of Teacher Design Teams

Teacher design teams (TDTs) are defined here as groups of teachers of adjacent subjects who cooperate in order to renew and redesign their curriculum and develop themselves professionally (at the individual, group and school level). McLaughlin and Talbert (2001) distinguished two types of professional communities that address curriculum design tasks. The first type enforces traditional methods of teaching. Here teachers work to transmit predetermined course materials and to administer department tests. A second type of professional communities develops innovative methods of instruction that achieve a better fit of the course work to the students. These teams centre their work on students, share responsibility and work on changes concerning all components of a curriculum. The work of the TDTs in our study focused on the second type of professional communities working on curriculum renewal. This section will address the issues of group composition and design activities of such TDTs.

Teachers who collaborate on the renewal of their curriculum may initially feel a loss of individual freedom to act on their personal preferences, without overview by colleagues. Moreover, group settings more readily reveal possible uncertainties in their teaching. Therefore, to collaborate effectively in a TDT teachers need to feel (cf. Hargreaves, 2003; Little, 1990):

- the need for each other's contributions in order to succeed in their own work;
- inspired by new perspectives that their colleagues, especially from other subjects, bring to the design table;
- to some degree a fit between naturally occurring teacher relationships and the artificially constructed links that are introduced (or imposed) in the service of improvement initiatives.

For these reasons, it seems preferable to compose teams of teachers from different but related subject domains.

When it comes to the matter of which teachers need to be actively involved in curriculum development efforts, there are several recommendations in the literature.

On the one hand, Fullan (1993) asserted that all persons involved should be a change agent. On the other hand, Skilbeck (1998) pointed out that as talents and interests vary, and as there are different kinds of development tasks to perform, matching procedures are inevitable, meaning that not all teachers need to be actively involved in all curriculum development tasks. The two suggestions are not contradictory per se. Variation in level of participation can remain supportive as long as all teachers share a common sense of direction. They all need to be involved, one way or another, in some stages and parts of the process of developing the new curriculum and to feel that they have collective responsibility for it.

The specific group size remains rather arbitrary, as it (to a certain extent) depends on the existing patterns within a school. However, there is some common sense in the message that the team needs to have at least two teachers (preferably more, to stimulate diversity in experiences and perspectives), but no more than about six teachers to maintain a workable organization of collaborative, content-related, activities.

Curriculum Development by TDTs

For both conceptual and practical reasons, curriculum development is often experienced as a complex endeavour. One of the major challenges TDTs confront is creating a curriculum that maintains consistency between all components of a curriculum. In order to address that complexity, we adhere to the metaphor of the so-called 'Curricular Spider Web' (Van den Akker, 2003), which includes ten interconnected issues related to the planning of student learning: rationale, aims and objectives, content, learning activities, teacher role, materials & resources, grouping, location, time, and assessment. This web helps with systematic design attention to all relevant questions about a curriculum as a plan for learning.

Another challenge refers to the different underlying processes of school and curriculum reform. These can be viewed from a substantive, socio-political and technical-professional perspective (Goodlad, 1994; House & McQuillan, 1998). When looking at the substantive choices to be made, teachers and other stakeholders implicitly (or sometimes explicitly) search for a balance between three major functions of education (cf. Goodlad, 1994; Van den Akker, 2003), related to the different perspectives of:

- Students: which elements seem of vital importance for learning based on the personal and educational needs and interests of the learners themselves?
- Society: which problems and issues seem relevant for inclusion from the perspective of societal trends and needs?
- Subjects: what is the academic and cultural heritage that seems essential for learning and future development?

In many ways, curriculum development is also a socio-political endeavour in which different values, beliefs and interests constantly play a crucial role. Choosing substance and making choices for all other curriculum components usually involves negotiation and compromises between stakeholders at the various curriculum levels (classroom, school and system).

Looking at curriculum development activities from the third (technical-professional) perspective, the literature offers many procedural models and strategies for curriculum development. However, in their daily practice, teachers tend to base their design decisions (about matters such as productive learner activities, relevant content, suitable resources, appropriate timing, and so forth) predominantly on their own materials, practical knowledge (what will and will not work in the classroom) including personal survival concerns, and beliefs about professional identity (Black & Atkin, 1996; Hargreaves et al., 2001; Olson, 2002; Walker, 2003). They use (often externally formulated) goals to validate their initial designs. Gustafson and Branch (2002) pointed out that teachers have less attention available for systematic design (with front-end analysis and rigorous formative evaluation), due to the ongoing nature of classroom instruction, often accompanied by a heavy teaching load and limited resources for development. As long as teachers work individually, these classroom-oriented design approaches may seem to be adequate. However, when teachers are working together as a team on the redesign of their joint curriculum, more effort needs to be put into discussing ideas and consequences and finding ways to come to an agreement. Here, a more systematic approach with some accompanying model may become helpful in order to provide a clear overview of (optional) development stages and activities and to predict timelines and coordinate activities, to reduce the complexity of the decision-making processes, and in communicating about it. Moreover, as teachers tend to put the practical context and the learners at the forefront of curriculum design, a prototyping approach probably suits design teams best. In addition, during an orientation stage, teachers may appreciate the help of a coach when exploring their zone of proximal development. These coaches can draw teachers' attention to interesting ideas and initiatives that are going on at other schools, for instance, by making site visits, attending workshops, and collecting information through literature study and the internet. After this exploration stage, teachers can make their design ideas explicit, and validate and pilot-test the new design. During these prototyping cycles the assistance of an external coach may also be valuable.

Curriculum Development and School Organization Development

Teacher collaboration in curriculum improvement efforts does not automatically lead to actual and lasting changes. In order to achieve fruitful curriculum renewal in schools, the organizational and working conditions need to support these efforts. The school context should become a powerful, professional learning environment for TDTs. This section will cover three conditions at the school level: an encouraging culture, suitable (infra)structure and powerful support for TDTs.

Encouraging School Culture

Culture can be defined as ‘the way we do things around here’ (Miller, 1998). In order to stimulate the work of TDTs within a context of school-wide curriculum change, the school should foster a culture that addresses collaboration and accountability in a meaningful way and embraces distributed leadership. Hargreaves (2003) has provided a framework for understanding how cultures and performance agreements (contracts) contribute to school renewal, including six culture and contract regimes (see Table 4.1).

Professional learning communities seem to be most supportive for school-wide and long-term change. Schools that foster professional learning communities stimulate working together by teachers, but they also insist that this joint work should consistently focus on improving teaching and learning and use evidence and data as the basis for informing classroom improvement efforts and for solving whole-school problems. In fostering learning communities, change, and improvement in schools, special attention should be paid to creating shared visions and goals. This is a crucial element in school culture that distinguishes ‘improving’ schools from ‘stuck’ schools (Rosenholtz, 1989; Stoll & Fink, 1996). Without a sense of shared goals in the school, collaborative action is not likely to occur. The existence of shared goals is in itself interrelated with the form of leadership and its distribution in the school (Rosenholtz, 1989).

From the perspective of theory of change, many authors have asserted that leadership shapes the teachers’ community. Deep change and secured long-term improvement call for a form of distributed leadership (cf. Hargreaves, 2003; McLaughlin &Talbert, 2001). Here leaders spread responsibility and ownership of community values throughout the school or department (for instance, by giving substantive roles to department chairs and working groups). Hargreaves (2003) stressed the importance of having a leadership team of complementary strengths: some who can bring about short-term efficiency (managers) and others who can secure long-term improvement (instructional leaders).

Table 4.1 Culture and contract regimes Hargreaves (2003)

		Performance contracts	
		No agreements	Agreements with accountability
	No collaborative culture	Permissive individualism	Corrosive individualism
Collaborative culture	Collaboration is encouraged	Collaborative cultures	*Professional learning communities*
	Collaboration is forced	Contrived collegiality	Performance training sects

Suitable School Structure

In order to achieve fruitful curriculum renewal, the structures within a school should foster the kind of school culture that was discussed in the former section. School-wide innovation processes are helped by at least two structures within a school: school infrastructure and coordination of the curriculum renewal. This section will elaborate on these issues.

Teachers who are involved in TDTs need to work in a context that fosters collaborative design and learning. McLaughlin and Talbert (2001) warned against the assumption that teacher collaboration and invention are self-sustaining or relying on isolated initiatives by individual teachers. According to Hargreaves (1997), there is need for both structural and cultural changes within the infrastructure of schools that provide time and stimulus for those activities that are characteristic of strong professional communities, such as reflection and interaction. This means, for instance, that teacher design teams:

- have time to design and learn that is scheduled together;
- have a suitable workplace for joint work;
- are buffered from outside disruptions;
- are (made) aware of knowledge resources and opportunities for learning inside and outside school and have some budget to work on these opportunities;
- are enabled to negotiate different understandings about practice.

During the process of school-wide curriculum change, the efforts of all TDTs should – at some point – converge into a joint rationale for the school curriculum. A framework for innovation can be helpful in this coordination. However, here a dilemma arises: on the one hand, TDTs need some clear boundaries around the innovation, in order to feel sure that the design they come up with will fit in with the overall rationale of the school. On the other hand, the overall rationale is often far from clear at the start of a change effort. Fullan (2003) even proclaimed that premature clarity is a dangerous thing. Nevertheless, from an early stage on, providing some tentative guidance can be of great help. On top of that, the renewal can be coordinated (cf. Fullan, 1999; McLaughlin & Talbert, 2001): for instance, crossover structures can support conversation and exchange in order to enable all participants and stakeholders to make connections and can integrate activities around common priorities. Here, principals are essential as integrators and synthesisers. They can help staff to attack incoherence, make connections, and focus on continuity from one program to another. Moreover, they can foster selectivity concerning the aims of the innovation; there is a great need to prevent the school from becoming a ‘Christmas tree school’ (Bryk et al., 1998a in Fullan, 1999), referring to the situation in which many schools make things worse by taking on every innovation that comes along (so many innovations as decorations, superficial adornment). In all renewal situations, it is advisable to cater for diverse and regular communication to all staff in the school about decisions being made, developments in the process, and progress recorded. This kind of communication helps participants with keeping on track, making their progress visible, and creating a ‘common process history’.

Powerful Support for Teacher Design Teams

According to Fullan (2001, p. 195): "… all successful schools and districts are proactively plugged into an external network of resources, professional development and other forms of assistance". In that sense, external involvement seems to be essential for success. Still, there is great ambiguity surrounding the kind of external support needed. This section covers three lessons learned from the coaching and consulting literature (Fullan, 2001; Huberman, 1995; Vandenberghe & Kelchtermans, 2002). First of all, effective coaching means 25% having good ideas, 75% helping develop local conditions. Fullan (2001, p. 191) pointed out: "It is not so much the product of reforms that worked elsewhere that needs to be replicated, but the conditions under which the reforms worked." This means that being a consultant requires having good ideas (theories of learning/education) and being very sophisticated about the complexities of relationships and motivations, so that the renewal falls within the 'zone of proximal development' of individual teachers and their schools (theories of change). Further, coaches are resource people, not group leaders. It helps when the team and the coach are clear about the specific expertise that the coach brings in. Huberman (1995) distinguished the following types of expertise: conceptual specialist, educator, didactic specialist, more experienced peer, formative evaluation specialist. On top of that, and especially where teachers are not used to cooperating, TDTs will be helped when a coach facilitates their group process. Finally, coaches have the important task of creating a context for engagement and sense-making. They assist teachers in leaving behind their routine teaching patterns, in reflection, and in making their knowledge explicit and accessible and help the team to come to emotional commitment to taking action. According to Vandenberghe and Kelchtermans (2002), reflection in a team should be broad (covering both technical skills as well as moral and emotional dimensions) and deep (coming to sense-making and preventing false clarity).

Conclusion: Teacher Design Teams as Propelling Force for Integrated School-Wide Curriculum Development

In order to achieve school-wide curriculum improvement with significant relevance for student learning, teachers need to be put in the forefront. Collaborative teacher learning by cyclical design (including analysis, piloting, reflection and sense-making) is at the centre of this approach. In order to further the curriculum quality and to encourage teachers' discourse and learning, teachers need to be encouraged to work jointly in small teams, defined here as teacher design teams. On the school level, the work of these TDTs needs to be embraced by a powerful learning and development environment (including supportive school culture, school leadership and support).

The role of TDTs in the intended interplay between curriculum, teachers and school development is visualised in the figure below (Fig. 4.1):

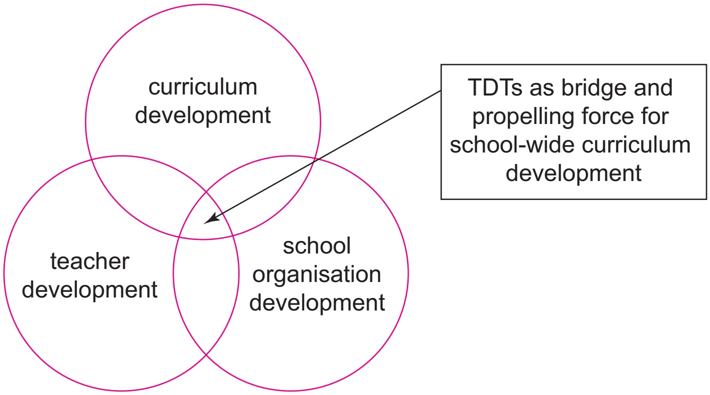


Fig. 4.1 TDTs interacting curriculum, teacher, and school development

Implementation Study

The rationale behind teacher design teams, as was elaborated in the former section, was the object of research at a junior secondary school that initiated and worked with seven teacher design teams during the period 2002–2004, to foster its school-wide curriculum renewal ambitions. This section will cover an introduction to the pilot site, and the research design, followed by the main findings and conclusions of the study.

Introduction to the Pilot Site

The pilot site was a school for secondary education with about 500 students. The school-based initiative for curriculum renewal focused on the first two grades of junior secondary (12- to 14-year-olds, about 250 learners). An assessment of baseline practice showed that at the starting point (October 2002), the classroom practices at this school were rather traditional with conventional textbook-driven lesson patterns. To the students, the overall curriculum showed little coherence and the day-to-day practices were fragmented and hardly challenging. However, the school had a pleasant and orderly atmosphere and the relationships between teachers and learners were good. The experienced and dedicated teachers were working in small but rather passive departments. Only limited collaboration was going on between the teachers and professional debate and deliberations were rare. The school professional culture resembled what can be described as 'permissive individualism' (Hargreaves, 2003). Although each individual teacher had some aspirations, there appeared to be a great gap between those articulated aspirations and their daily practices.

In the years preceding 2002, several small-scale innovation initiatives had already been carried out within the school. However, they did not prove to be sustainable and did not reach all teachers. Meanwhile, the school leaders were working on a – rather open – innovative vision for the first and second grades of junior secondary. The main aspirations in this vision can be summarised as follows:

- from a teacher-oriented program towards a student-centred approach;
- more coherence between subject domains;
- more activity-based learning, with more responsibility and options for learners;
- less fragmented schedule, with longer time periods for learning;
- task differentiation for teachers and support staff;
- more integration of ICT-use.

From 2002 on, the school worked towards these aims. An important characteristic of the innovation process was its school-wide approach and evolving (phased) nature. The approach did not aim at isolated projects in a few subjects, but from the start, active involvement of all junior secondary teachers was stimulated. In order to bridge the gap between the general school level and the individual teachers, the school realised a structure wherein seven teacher design teams were composed (each of about three teachers of related subjects). These teams re-examined their joint domain curriculum and worked together on the design, piloting and implementation of a renewed common curriculum for their domains. In addition, each team was assigned a coach (an external expert in pedagogical content knowledge and curriculum) as facilitator and resource person. Two school leaders (the principal and an innovation manager) were responsible for overall facilitation and coordination. Moreover, as part of the new school structure a core team (with the leaders of each TDT) met regularly, in order to exchange ideas, to discuss problems and needs, and to serve as a platform for coming to some convergence in the innovation.

It took the school one school year (2002–2003) to redesign and develop the entire first grade's curriculum renewal. Starting in August 2003, this curriculum was implemented. During that school year (2003–2004) an implementation study was carried out. The next sub-section will provide a brief overview of the research design of that study.

Research Design

The main question of the implementation study was: "How does the curriculum renewal process of the school evolve, particularly in the teacher design teams?" The main respondents in this implementation study were the students, teachers, teaching assistants, team coaches, school leader, and innovation manager. The research activities included document analyses (minutes of team meetings, curriculum materials and team curriculum frameworks) and semi-structured (individual or group) interviews with the students, the school leader and innovation manager, the teachers and teaching assistants and the coaches. Interviews with respondents were conducted at the end of the first implementation year (June, 2004). The interviews were 60–90 min long and were all tape-recorded. Interviews were analysed on basis of a flexible analysis scheme that evolved during interview analysis.

Main Findings

This section covers the main findings of a study on the first implementation year (2003–2004) at the school site. By June 2004, the TDTs had taught according to the new curriculum during one school year and had worked on the curriculum for the second grade. Table 4.2 provides a description of the work of three TDTs, those for Foreign Languages, Social Studies, and Science (Nature & Technology) that reflect well the various patterns of all teacher design teams at the school. It is beyond the scope of this chapter to provide detailed information on all of the teams. Table 4.2 serves to summarise the findings of the implementation study, focusing on:

- Characteristics of the TDTs and team development
- Curriculum development within the TDTs
- Teacher development and learning experiences
- School organization development, including school structure, culture and external support.

The following sections give a description of the main findings on these categories, using examples from the three teams whose information is summarised in Table 4.2.

Characteristics of the TDTs and Team Development

The following seven teacher design teams were composed:

- Foreign Languages: English, German, French
- Social Studies: History, Geography, Home Economics, Religious Studies
- Science (Nature & Technology): Physics, Technology
- Science (Nature & Health): Biology, Health Education
- Arts (Music, Drawing, Crafts)
- Mother tongue (Dutch)
- Mathematics.

Most of these teams consisted of more than two teachers. The Social Studies team was the largest, with five teachers. It is interesting to note that the team members on several teams (such as Foreign Languages and Social Studies) did not have much previous cooperation experience. Within these teams, views of the innovation and the commitment levels were quite diverse. The goals of the cooperation varied from subject alignment without integration (for instance, Foreign Languages) to full subject integration (for instance, Nature & Technology). In particular, the teachers in this latter team had cooperated before and showed great commitment to change. Probably due to their explicit ideas, the team did not feel the need for an external coach, and preferred to work on their own instead. The remaining teams did have an external coach.

Although the teachers had been working in the same school for many years, the teachers on most teams had no prior experience with cooperating with one another.

Table 4.2 Summary of the findings of the implementation study

	Team #1- foreign languages	Team #2 – social studies	Team #3 – science (nature and technology)
Characteristics of team	3 experienced teachers	5 teachers – varied experience	2 teachers
	Coach	Coach	No coach
	No prior cooperation	No prior cooperation	Prior association
	Diverse views of innovation and commitment levels	Diverse views of innovation and commitment levels	Teacher commitment and enthusiasm to project
	Goal of cooperation: alignment but no integration	Goal of cooperation: not clear at start	Goal of cooperation: subject integration
Team development	Rough start – finding common ground proved difficult	Rough start – finding common ground proved difficult	Smooth start and cooperation
	Concrete discussion of one member's plans led to open discussion of all plans	Joint work led to acquaintance with colleagues	Diverging approaches in team accepted
	Team's cooperation formalised in concrete habits	Unbalanced investment of time and energy in process led to tension in cooperation	
	Presentation of team's successes to other teams strengthened cohesion	Subject borders still played a role – little interaction outside team meetings	
	No further cooperation outside direct team activities		
Curriculum development	Material development occurred separately – teachers used one another's ideas	Framework defined commonly, but development done separately; varying levels of dedication; two teachers mainly responsible	Common themes defined; material developed individually
	New textbooks used as basis for new design	Substantial part independently constructed	One teacher relied on textbook; another developed material independently
	In team meeting, comments on separate plans led to adjustments	In team meetings, discussion of framework; little discussion of specific lesson plans	Team meetings ensured coherence of themes and exchange of concerns
	Use of pilot of intended work scheme to evaluate design	Pilot of an intended learning activity	Systematic evaluation of implementation led to adjustments of learning materials

(continued)

Table 4.2 (continued)

	Team #1- foreign languages	Team #2 – social studies	Team #3 – science (nature and technology)
		Formal and systematic evaluation of implementation led to radical adjustments in structure	
Professional development and learning experiences	Interaction about designed materials and innovation goals led to new insights	Developing and constructing material raised questions and responses	Developing and constructing material raised questions and led to new insights
	Pilot led to new idea by teacher involved	Implementation and evaluation led to new insights, used in planning for the next grade	Interaction with content experts on possibilities was inspiring for teachers
	Implementation indicated as important learning process	Leadership role was significant learning stimulus for the leader	Implementation and evaluation led to new ideas, used in adjusting design and planning the for the next grade
	In adapting plans, tension between 'old habits' and innovation	At the end of 2nd year, team committed to collaboration; opted to continue collaboration	At the end of 2nd year, members committed to collaboration and innovation; critical of other teams for lacking it
	At the end of 2nd year, all teachers committed to innovation		
Perceived role of school management	Vague innovation guidelines and latitude for team	Vague innovation guidelines and latitude for team	Innovation guideline perceived as vague, room for team initiatives and ideas
	Lack of communication with project management	Decision-making structure vague	Pacified early incident concerning external coach
	Responsive when approached with requests and questions	Reserved in informing activities of team and intervening	Gave member additional tasks of coordination at school level
	Project manager crucial in securing consistent engagement of all teachers on the team	Responsive when approached with requests and questions	
		Reallocated task-hours to teachers to suit teachers' investment	

(continued)

Table 4.2 (continued)

	Team #1- foreign languages	Team #2 – social studies	Team #3 – science (nature and technology)
Role of external support	Very proactive in interventions and discussions	Reactive, responded to team's questions	Interaction with content experts on possibilities was inspiring for teachers
	Made permanent connections between plans and innovation goals	Assisted in finding common ground and form of cooperation	Support by researcher in negotiation with management concerning facilities
	Controlling of and commenting on plans	Suggested possible designs for common projects	
	Structured work process: meeting's structure, writing of common curriculum plan	Support for chairperson	
	Exposed team to alternative practices	Developed curriculum materials in accordance with team plans	
	Supplied curriculum materials	Researcher played role in designing evaluation	
		Researcher instrumental in clarifying discussions	

They spent the first period of team work on getting acquainted with their colleagues and their coach, and on exploring their views on teaching, on the direction for the innovation and on the cooperation process. Most teams encountered difficulties in articulating their wishes and goals and sharing these with their colleagues (the Foreign Languages and Social Studies teams, for instance). This was also complicated, as they perceived the innovation goals and structure to be rather vague. Larger teams involving more different school subjects had greater difficulty negotiating these issues and agreeing on a common work process, as was the case with the Social Studies team. After this initial stage, when teachers had gained more confidence the discussions became more content-related and teachers expressed their wishes and preferences more openly.

Through the concrete work of planning and materials development, teachers got to know each other better. They learned which of their colleagues had the same overall ideas and on which colleagues they could rely on from a process-related point of view. It appeared that, especially in teams with high aspiration levels and/or covering more than two subjects, the collaboration was demanding and more difficult (as was the case with the Social Studies team). Here there was tension regarding the amount of time and energy that all team members needed to invest in the innovation.

Occasions where teams were invited to present their work to their peers worked as catalysts for team development. These events forced the team to formulate a common position and to strengthen their identity as a team (as articulated by the Foreign Languages team). Up to this point, the teacher cooperation had remained mainly within the team and subject-borders kept playing a significant role. However, an interesting emerging phenomenon was that teachers who had similar ideas about the innovation but came from various teams seemed to start conferring with one another.

Curriculum Development Within the TDTs

During the preparation year, the teams operated very differently in designing their curriculum. The characteristics of the process varied from an individualistic approach based on new textbooks and the exchange of inspiring ideas (the Foreign Languages team), to a commonly defined framework and design (the Nature & Technology and Social Studies teams). For instance, all teachers on the Social Studies team decided together on the themes and organization of a project, while two of its teachers were made primarily responsible for the actual design of the materials. In each team, discussions of the plans led to some adjustments. Those teams that performed a systematic formative evaluation (for instance, Social Studies and Nature & Technology) came to even more radical adjustments.

The curriculum development activities during the first implementation year were especially geared towards enactment of the designed curriculum for the first grade of junior secondary and the design and development of the curriculum for the second grade. As far as the implementation efforts were concerned, the teams worked mainly on problems related to the actual implementation of their curriculum part. They appeared to have a less keen eye for the consistency of the entire curriculum. It seemed that the design of the curriculum for the second grade went easier, especially because the teams could follow up on earlier decisions already made in the preparation year and because they were more acquainted with the design activities.

Teacher Development and Learning Experiences

The work of the teams in the preparation year comprised two main activities. First, the teams tried to explore what the school-wide innovation aims might imply for their subjects. They jointly oriented themselves regarding current and alternative practices through consulting the literature, video and internet, making school visits, attending workshops, and contacting publishers. Second, the teams made joint efforts to formulate a tentative curriculum (based on reflection, exchange and deliberation and -in a few instances- on small-scale try-outs of exemplary practices and follow-up design, as happened in the Foreign Languages and Social Studies teams). Based on those activities, teachers developed new subject- and pedagogy-related insights. Moreover, the actual implementation of the first grade curriculum proved to be a key learning opportunity, especially in those teams with high ambitions (for instance, Nature & Technology). The teachers became aware of the parts that went well and the parts that needed modifications.

In addition, the school-wide meetings with all teams stimulated the teachers to make their plans explicit, to justify these, to present them to their peers on other teams and to interact with their peers and get suggestions for improvement. This kind of interaction greatly assisted their reflection on the curriculum renewal.

School Organization Development

Initially, the school leaders faced a dilemma concerning the amount of freedom and restrictions they should give to the teams in the redesign of their curriculum. At the start of the project, they gave great latitude and just a few guidelines to the teams. The leaders formulated a broad innovation framework and held back from interfering with the work of the teams. Coordination and communication structures were somewhat ambiguous. For instance, the core team seemed to function somewhat inefficiently, as not all teams had representatives on it and the discussions were often perceived to be not very productive.

The school structure as realised at the start of the process remained quite stable during the first 2 years of the reform initiative. The teams, core teams and communication channels that were initially established remained the same. In the course of the process the school leaders did, however, change their informal support efforts to be more tailor-made and demand-driven. Although this was done hesitantly, they started to approach the teams more informally and they intervened in the work of teams in order to solve a pending problem or to give direct information on a concrete question, in particular.

The professional culture of the school displayed changes in the course of the process. Increasingly education and teaching became topics of discussion in the teachers' room and school halls as a distinct part of informal discourse. Sharing experiences and information, asking each other for help or assistance, and commenting on one another's work became part of regular practice. This was especially true for the relationships of teachers within the TDTs, but increasingly so also for teachers across teams. School meetings where teams presented their designs and plans and received comments from their colleagues became regular events at the school.

All teams perceived the innovation guidelines as being vague and unclear. This led to different reactions. Whereas one team (Nature & Technology) used this lack of clear guidance as the basis for deciding on its own course for the innovation, the lack of guidance did lead to confusion and misunderstanding within most teams and to a call for more coordination and a unified school framework. As a consequence, the leadership demanded that the teams deliver their tentative plans. However, this also created difficulty, as some teams were already beyond that initial point in their process and found it redundant, while other teams were not yet able to produce such documentation.

Teams experienced little and unstructured communication from the project management concerning developments in the projects, and decisions made at the school level and at the level of other teams. Some teams (like Foreign Languages) opted as a result to rely on informal and direct contact with the project management to make inquiries and requests. Although this appeared to be an effective means of achieving their goals and they were satisfied with the management's response to their requests, they were dissatisfied with the fact that they had to 'chase' the information instead of it being communicated regularly.

Although the management was perceived as being reserved in intervening in the work of the teams and even in enquiring into the details of what they had developed, some practical interventions in team work were appreciated and perceived as effective and necessary. These interventions were directed, for example, at resolving administrative issues to enable the work in the team (Social Studies team) or securing the consistent participation of all team members (Foreign Languages team).

External Support

With the exception of the Nature & Technology team, got an external coach. Because of the open innovation framework, the vaguely defined role of coaches, and the fact that the teachers did not know what to expect from the coaches, there was a mismatch of expectations in some instances. A great variety of approaches to coaching and working with the teams was apparent within the school. The coaches varied considerably, especially with respect to their degree of directiveness. Where one coach was very proactive, initiated many interventions, and structured the team's work process (as was the case with the Foreign Languages team) other coaches were more inclined to be more reactive to what was developed within the team, initiating actions only on specific requests by the team (as was the case with the Social Sciences team). This variation was also evident in the types of activities they pursued with the team (such as assisting in construction of materials, structuring team processes, and presenting teachers with alternative practices).

In the preparation year, the role of most coaches was concentrated on helping the team to define their specific innovation framework and plans. Most coaches focused on trying to align the team's plans with those of the school, as was apparent in the Foreign Languages team. This was done by commenting on emerging plans and linking them to the broader framework. In some cases, the coaches helped in writing the plans and supplied useful educational materials. Involvement of the coaches in curriculum evaluation activities appeared to enhance the systematic character of the evaluation. In the 2nd year, when the outlines of the teams' curricula were clearer, this influence of the coach diminished somewhat, although the more proactive coaches, such as the one for the Foreign Languages team, remained dominant in the 2nd year.

Conclusions of the Implementation Study

The empirical findings showed great variety in the evolving innovation processes of the different teacher design teams. Within one (relatively small) school, seven teams operated in different ways, got diverse forms of external support, perceived the school context differently and produced varying products. Based on these findings, we came up with a number of conclusions and accompanying advice for schools, teachers and external coaches that aim at pursuing a teacher design team scenario in the context of school-wide curriculum development.

Characteristics of TDTs

As far as the group composition is concerned, the great variety across the teams did not lead to transparent suggestions for the future. The larger teams showed more variation in personality and visions. Teams need to have some diversity for inspiration and to have something to discuss. However, if the intentions and motivation to work on the renewal project are too divergent, this may also lead to friction. The smaller teams with less variation among their members were able to arrive fairly early at a common platform of ideas. However, here the innovation process was sometimes hampered by a lack of inspiring ideas and discussions. Based on this, we offer the following suggestion:

- In order to have sufficient effective discourse, external coaches should be especially aware of friction in a team, make this friction explicit to the team and look together for ways to act on it. In smaller teams, more attention should be given to the introduction of possible alternatives and new ideas.

The findings illustrate that in some instances the TDTs decided to divide up their common design tasks among the team members. Although a great deal of cooperation was going on, it did not always lead to joint work and meaningful discussion about these individually completed design tasks. One may wonder how much collaborative learning was going on. This leads to the following suggestion:

- Although a task division approach is understandable from a pragmatic perspective, teams need to pay special attention to stimulating meaningful interaction concerning their design and they need to support their learning process, for instance, by deliberating on a common overall framework, by joint appraisal and piloting of the design and by organizing reflection meetings.

Teacher Development

The findings show that teachers who were involved in their team's design activities felt that their learning needs became more apparent and clearer as soon as they started experimenting with their designs in daily practice and implementing them. This finding leads to several points for attention:

- Actual implementation leads teachers to reflect on the strengths and weaknesses of their design and to initiate follow-up actions. Given the fact that reflection is such a central element in learning, this reflection process should get specific attention, for instance, from external coaches who provide focus questions before and after the implementation.

- In order to increase teachers' chance of having multiple reflection experiences, it seems helpful to have ample opportunities for piloting 'experimental' learning and teaching approaches at an early stage of development, instead of waiting till the next year for the implementation of the new or revised curriculum.

In sum, taking the role of teachers as learners and designers seriously calls for an iterative and evolutionary curriculum design approach, with special attention for the reflection process based on experiences with the design in classroom practice.

Curriculum Development

The curriculum development activities carried out by the teams were rather unstructured and showed some imbalance. Most teams started working on the organizational components of the renewal (timetable, sequence of the content) and put less effort into the implications for their own teaching roles and pedagogical changes. This leads to the following suggestion:

- From a curricular perspective, it is fruitful to make use of the 'Curricular Spider Web', which offers a cadre of ten curriculum components, in order to underline the importance of consistency between all curriculum design choices at the team and school levels.

School Organization Development

Interesting enough, during the process culture change was not high on the school leaders' priority list. However, based on the findings it becomes clear that the school's professional culture changed from a culture typified as 'permissive individualism' towards a more collaborative culture. On a regular basis, at school meetings and, maybe even more importantly, at informal meetings during breaks, teachers presented and discussed their joint work, shared experiences and information, asked colleagues for assistance, and commented on one another's work. This finding leads to the following suggestion:

- Although more profound results may be accomplished when culture change is stressed more during the process, it seems that the work of TDTs together with regular school-wide meetings has valuable potential in this direction.

The variety in the teams' innovation processes is related to a great dilemma in the process. On the one hand, it is necessary to let teams work on a design that is relevant to them and at a speed that suits them. On the other hand, there is the need to arrive at a coordinated school framework that is coherent, practical and realistic. This dilemma leads to several points for consideration:

- Variation among participants (teachers, teams) should not be regarded as an obstacle, but as a normal feature of development processes. Differences in tasks,

style, commitment, and support should be expected, and sometimes perhaps even encouraged.
- In order to foster curricular cohesion, much emphasis should be put on (both formal and informal) communication between all stakeholders in the process. All sorts of (ongoing) communication are helpful for stimulating the development process: personal/organizational; formal/informal; written/oral. Documentation of processes and (preliminary) outcomes is beneficial for progress, although overload of bureaucratic paperwork should be avoided.
- The school organization can facilitate the collaborative development activities by creating smart cross-over patterns, by offering adequate working arrangements, and by alert handling of emerging organizational and logistic problems. Leadership tasks and responsibilities should be distributed within the organization.

The external support in these decentralised school improvement processes also brought forward a dilemma. Although there was no single best direction in the innovation process, there was (from a coherence point of view) no complete freedom for the teams. For the coaches, there was tension between being too dominant and steering (pushing the team in a certain direction) and being reactive and somewhat passive (just following the teams and waiting for their initiatives and achievements). The coaches handled this dilemma in various ways, which led to the following suggestions:

- Active deliberation and articulation of the needs and wishes of the team and its coach appear to lead to better alignment of the expectations and a more fruitful innovation process.
- Most teams do expect a proactive coaching style, especially in the early stages. Being only reactive does not seem to be very productive.
- In order to leave behind routine patterns and bring in inspiring ideas that lead to discourse, it seems to be good advice to assist teachers during the orientation stage with exposure to alternative approaches and views.

Finally, no matter how well conceived the innovation approach is, change processes are bound to be turbulent and to create insecurities, tensions and emotions. Thus, the suggestion for all participants is to be tolerant of frustrations, to be keen in identifying and celebrating successes, and to maintain a flexible approach, characterised by experiential learning.

Reflections After More Than a Decade of TDT-Related Studies

Trends in TDT Approaches

To our knowledge, this study (that began 15 years ago) was the first study that used the concept of Teacher Design Teams (TDTs), representing the beginning of a research line.

Since then, this label and its corresponding rationale and approach have become very popular in the Netherlands. Several doctoral dissertations on the TDT approach have been conducted (cf. Bakah, 2011 Handelzalts, 2009; Huizinga, 2014), and a number of other studies regarding TDTs have been published (see overviews in, for example, Huizinga, Handelzalts, Nieveen, & Voogt, 2014, and this volume).

Perhaps even more remarkable and relevant is the very rapid expansion of TDTs in the practice of curriculum improvement in interaction with teacher professional learning and school development. The TDT approach appears to be very appealing to many practitioners. Moreover, at the policy level, TDTs are also viewed and promoted as a very promising strategy for local educational improvement, as can be observed in documents prepared by the Dutch Ministry of Education.

In many more recent projects, however, TDTs have been applied in settings where teachers from various schools work as a collective. Usually, the emphasis in such multi-school projects is more on fostering the professional learning of teachers (mostly within the same subject) than on school-wide curriculum improvement within a specific school. Many experiences have been gathered on how teacher design teams work, how teachers learn, and how school organization and coaches affect these teams. Although the multi-site, single-subject approach is definitely interesting, it has less to do with the kind of organizational, socio-political dynamics and capacities that are involved in school-specific and school-wide curriculum development endeavours. The challenge of maintaining curricular coherence between subjects is also less at stake. Thus, although the specific combined aspirations for teacher development, curriculum development, and school development in our study and view of TDTs seem not so often pursued, their relevance is perhaps greater than ever, considering the current policy aims introduced at the start of this chapter.

Way Forward: Teacher Design Teams in the Context of Recent Curriculum Policy

The lessons learned for this original study appear to have particular relevance in view of recent policy developments and school realities, pointing to a renewed strong interest in school-based curriculum development. The importance of team learning and development has been re-discovered and again emphasised, especially for school-specific curriculum renewal (Onderwijsraad, 2017). The findings of our study are, in our opinion, still meaningful and worthwhile, when considering how to address this challenge. For that reason, we conclude this chapter with a summary list of eight major principles and accompanying activities for the work of TDTs in schools that are active in the field of school-based curriculum development (Table 4.3). This list was incorporated in one of the articles about the study that we discussed in this chapter (Nieveen, Handelzalts, & Van den Akker, 2005). In view of recent trends, the near future will bring ample opportunities to apply and evaluate the scenario of TDTs in the context of school-wide curriculum development, hopefully resulting in refinement and enrichment of the underlying principles.

Table 4.3 Eight principles for Teacher Design Teams in school-wide curriculum development

Curriculum development – Principles and supportive activities	
1. Think big, but start small	Picture the school-wide changes
Formulate school-wide intentions, but work stepwise towards these ends	Mobilise all teachers
	Elaborate smaller parts that fit the bigger picture
	Stimulate relatively rapid alternation of design and try-out activities to speed up experiential team learning about the curriculum renewal
	Use phases (e.g., per grade instead of all grades at one go)
2. One size does not fit all	Be clear about what the changes entail
Use a common framework, but provide room for specific choices	Explain the bandwidth of the framework (degrees of freedom)
	Make room for alternative solutions
	Expect teachers to negotiate
	Go back and forth between the innovation framework and the room for specific choices
3. Think broadly, but keep an eye on the learners	Start from a learner's perspective and a vision on learning
Make sure that learners remain at the centre of the renewal	Consider consistency by using the curricular spider web for analysing the current curriculum-in-action, for characterising the intended curriculum, and for evaluating the renewed curriculum practice
	Consider longitudinal consistency among grades as well
Teacher development – Principles and supportive activities	
4. Work together	Make TDTs of two or more teachers of (adjacent) subjects who are responsible for their common curriculum
Make collaboration happen in and amongst teacher design teams	Use a differentiated development approach per TDT
	Consider necessary collaboration and planning skills of TDTs
5. Design in a cyclical manner	Analyse and describe the starting situation at the school
Make use of a cyclical development approach	Explore the zone of proximal development through collaborating on orientation about current and alternative practices (site visits, conversations, literature, experts)
	Formulate a common platform of ideas for renewal
	Design parts of the renewal
	Pilot test collaboratively to support common experiences
	Reflect on results
	Revise the design
	Make plans and findings explicit (on paper or other media)
School organization development – Principles and supportive activities	
6. Create a supportive school culture	Give TDTs responsibility for several years

(continued)

Table 4.3 (continued)

Create a culture of responsibility and distributed leadership	Formulate a (modest) requirement concerning what all TDTs need to deliver at a minimum
	Encourage TDTs to negotiate with the leadership about roles and expectations
	Assist TDTs in using the room for freedom (don't fill it up for them too quickly)
	Invite teams to look for evidence of the effects and discuss this evidence
	Vary in leadership styles: Stay closer to teams who do not have a clear informal leader
	Combine a rational and relational approach: visit the TDTs frequently
	Be prepared for emotions, tensions and misunderstandings and act on them
	Be tolerant of mistakes and insecurity
	Notice initial successes and build on them
7. Create a supportive infrastructure	Take care of facilitation: time for design and collaboration, inspiring work place, budget
Create an infrastructure that supports the necessary culture	Communicate carefully: communicate a lot in various ways
	Be responsive to questions and give follow-up
	Ask for and use feedback from learners and parents
	Formulate and appreciate successes
	Coordinate the renewal and take care of syntheses by realising cross-over structures and supporting connections
8. Provide external support	Show initiative, but avoid becoming the leader
Offer proactive and responsive support	Negotiate about the supportive role
	Take care to support the process (listening and observing; differentiating the support, making it possible to express concerns)
	Bring in relevant suggestions
	Support evaluation activities
	Create a context for meaning-making (success experiences, broad and deep reflections, make knowledge gains explicit)
	Assist in the determination to become active

References

Bakah, M. (2011). *Teacher professional development through collaborative curriculum design in Ghana's polytechnics*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is–or might be–the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6–14.

Black, P., & Atkin, J. M. (Eds.). (1996). *Changing the subject. Innovations in science, mathematics, and technology education*. London: Routledge.

Cochran-Smith, M., & Lytle, S. L. (1999). Relationship of knowledge and practice: Teachers learning in communities. *Review of Research in Education, 24*, 249–305.

Fullan, M. G. (1993). *Change forces: Probing the depth of educational reform*. London: Falmer Press.

Fullan, M. G. (1999). *Change forces: The sequel*. London: Falmer Press.

Fullan, M. G. (2001). *The new meaning of educational change*. New York: Teacher College Press.

Fullan, M. G. (2003). *Change forces with vengeance*. London: Routledge Falmer.

Goodlad, J. I. (1994). Curriculum as a field of study. In T. Husén & T. N. Postlethwaite (Eds.), *The international encyclopedia of education* (pp. 1262–1267). Oxford, UK: Pergamon.

Grossman, P., & Stodolsky, S. (1995). Content as context: The role of school subjects in secondary school teaching. *Educational Researcher, 24*(8), 5–11.

Gustafson, K. L., & Branch, R. M. (2002). *Survey of instructional development models*. Syracuse, NY: ERIC.

Handelzalts, A. (2009). *Collaborative curriculum design in teacher design teams*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Hargreaves, A. (1997). From reform to renewal: A new deal for a new age. In A. Hargreaves & R. Evans (Eds.), *Beyond educational reform: Bringing teachers back in* (pp. 105–125). Buckingham, UK: Open University Press.

Hargreaves, A. (2003). *Teaching in the knowledge society. Education in the age of insecurity*. New York: Teachers College Press.

Hargreaves, A., Earl, L., Moore, S., & Manning, S. (2001). *Learning to change. Teaching beyond subjects and standards*. San Francisco: Jossey-Bass.

Hopkins, D. (2001). *School improvement for real*. London: Routledge Falmer.

Hord, S. (2004). *Learning together, leading together. Changing schools through professional learning communities*. New York: Teachers College Press.

House, E. R., & McQuillan, P. J. (1998). Three perspectives on school reform. In A. Hargreaves, A. Lieberman, M. Fullan, & D. W. Hopkins (Eds.), *International handbook of educational change* (pp. 198–213). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Huberman, M. (1995). Professional careers and professional development: Some intersections. In T. R. Guskey & M. Huberman (Eds.), *Professional development in education: New paradigms and practices* (pp. 193–224). New York: Teachers College Press.

Huizinga, T. (2014). *Developing curriculum design expertise through teacher design teams*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. (2014). Teacher involvement in curriculum design: Need for support to enhance teachers' design expertise. *Journal of Curriculum Studies, 46*(1), 1–25.

Kuiper, W., Nieveen, N., & Berkvens, J. (2013). Curriculum regulation and freedom in the Netherlands: A puzzling paradox. In W. Kuiper & J. Berkvens (Eds.), *Balancing curriculum regulation and freedom across Europe* (CIDREE yearbook 2013) (pp. 139–162). Enschede, The Netherlands: SLO.

Kuiper, W., Van den Akker, J., Hooghoff, H., & Letschert, J. (2006). Curriculum policy and school practice in a European comparative perspective. In J. Letschert (Ed.), *Curriculum development re-invented* (pp. 56–77). Enschede, The Netherlands: SLO.

Kwakman, K. (2003). Factors affecting teachers' participation in professional learning activities. *Teaching and Teacher Education, 19*(2), 149–170.

Lieberman, A., & Miller, J. (2004). *Teacher leadership*. San Francisco: Jossey-Bass.

Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*, 509–536.

McLaughlin, M. W., & Talbert, J. E. (2001). *Professional communities and the work of high school teaching*. Chicago: The University of Chicago Press.

Miller, L. (1998). Redefining teachers, reculturing schools: Connections, commitments and challenges. In A. Hargreaves, A. Lieberman, M. Fullan, & D. W. Hopkins (Eds.), *International handbook of educational change* (pp. 529–543). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Nieveen, N., Handelzalts, A., & Van den Akker, J. (2005). *Leren van schoolvoorbeelden: Principes voor kansrijke onderwijsvernieuwing* [Learning from school examples: Principles for promising educational improvement]. Enschede, The Netherlands: SLO.

Nieveen, N., Handelzalts, A., Van den Akker, J., & Homminga. S. (2005). *Teacher design teams: A scenario for school-based curriculum innovation*. Paper presented at ECER, Dublin.

Nieveen, N., & Kuiper, W. (2012). Balancing curriculum freedom and regulation in the Netherlands. *European Educational Research Journal, 11*(3), 357–369.

Nieveen, N., Sluijsmans, L., & Van den Akker, J. (2014). Encouraging curriculum change in the Netherlands: The next episode. In F. Nyhamn & T. N. Hopfenbeck (Eds.), *From political decisions to change in the classroom* (pp. 162–183). Oslo, Norway: The Norwegian Directorate for Education and Training.

Nieveen, N., Van den Akker, J., & Resink, F. (2010). Framing and supporting school-based curriculum development in the Netherlands. In E. H.-F. Law & N. Nieveen (Eds.), *Schools as curriculum agencies: Asian and European perspectives on school-based curriculum development* (pp. 273–283). Rotterdam, The Netherlands: Sense Publishers.

Olson, J. (2002). Systemic change/teacher tradition: Legends of reform continue. *Journal of Curriculum Change, 34*(2), 129–137.

Onderwijsraad. (2017). *Een ander perspectief op professionele ruimte in het onderwijs: Versterk vermogen om te handelen vanuit het team* [Another perspective on professional space in education: Strengthen agency from the team]. Den Haag, The Netherlands: Onderwijsraad.

Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–16.

Rosenholtz, S. J. (1989). *Teachers' workplace. The social organization of schools*. White Plains, NY: Longman.

Shulman, L., & Sherin, M. (2004). Disciplinary perspectives on fostering a community of teachers as learners [special issue]. *Journal of Curriculum Studies, 36*(2), 133–271.

Skilbeck, M. (1998). School based curriculum development. In A. Hargreaves, A. Lieberman, M. Fullan, & D. W. Hopkins (Eds.), *International handbook of educational change* (pp. 121–144). Dordrecht, The Netherlands: Kluwer Academic Publishers.

SLO. (2015). *Curriculumspiegel 2015. Deel A: Generieke trendanalyse* [Curriculum mirror 2015. Part A: Generic trend analysis]. Enschede, The Netherlands: SLO.

Snyder, J., Bolin, F., & Zumwalt, K. (1992). Curriculum implementation. In P. W. Jackson (Ed.), *Handbook of research on curriculum* (pp. 402–435). New York: Macmillan.

Stenhouse, L. (1975). *An introduction to curriculum research and development*. London: Heinemann Educational Books.

Stoll, L., & Fink, D. (1996). *Changing our schools*. Buckingham, UK: Open University Press.

Van den Akker, J. (2003). Curriculum perspectives: An introduction. In J. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Vandenberghe, R., & Kelchtermans, G. (2002). Leraren die leren om professioneel te blijven leren: Kanttekeningen over context [Teachers learning to continue learning professionally: Reflections on context]. *Pedagogische Studiën, 79*(4), 339–351.

Walker, D. F. (2003). *Fundamentals of curriculum*. Fort Worth, TX: Harcourt Brace College Publisher.

Chapter 5
Culturally Sensitive Curriculum Development

Chantal Gervedink Nijhuis

Introduction

Because education is one of the pillars of a society, a lot of political effort and expertise is put into the development and improvement of educational systems. With the support of donors such as the World Bank, the International Monetary Fund, UNESCO, and national governments, many international cooperation projects have been initiated to support educational improvement in developing countries. To achieve these overarching, ambitious goals of educational change and improvement, multi-faceted, wide-ranging strategies are necessary (Plomp & Thijs, 2002; Thijs, De Feiter, & Van den Akker, 2002), in particular in the domain of curriculum development. In this study, curriculum is defined in its almost classic form as 'a plan for learning' (Taba, 1962) and curriculum development as (Van den Akker, 2003): '*usually a long and cyclic process with many stakeholders and participants; in which motives and needs for changing the curriculum are formulated; ideas are specified in programs and materials; and efforts are made to realize the intended changes in practice'* (p. 2). In order to achieve effective curriculum reform that establishes changes in educational practices, methodical and context-sensitive curriculum development is essential. Throughout the years, many models have been introduced to depict the various curriculum development activities included in the curriculum development process. Most models are based on a generic approach to educational and curriculum development, in which development tasks are categorised under analysis, design, development, implementation and evaluation activities (Wedman & Tessmer, 1993). Various external factors and trends affect the process of curriculum development, such as government policies, technological innovations, and stakeholder pressure (Fullan, 2007). Since curricula cannot stand on their

C. Gervedink Nijhuis (✉)
Royal Dutch Kentalis, Sint-Michielsgestel, The Netherlands
e-mail: c.gervedinknijhuis@kentalis.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_5

own but must be fitted to societal conditions and political views, collaboration between stakeholders has typically been stressed, as well as the need to account for local contexts and cultures in the process of curriculum development.

In international cooperation projects, the stakeholders involved in the curriculum development process have different cultural backgrounds, and the context in which curriculum reform is intended to take place is shaped by culture in a way that is often unfamiliar to the stakeholders. Therefore, international project teams are challenged to take culture into account in their curriculum development endeavours. However, difficulties are experienced in developing strategies for responding to cultural differences in development processes aiming at curriculum reform. In response to these problems, the study reported in this chapter and carried out in the PhD project by Gervedink Nijhuis (2012), was conducted to identify critical cultural factors in curriculum development processes in international cooperation projects.

Cultural Diversity in International Cooperation

According to Diallo and Thuillier (2004), international cooperation projects are managed by units or teams at a national level or by executive agencies such as NGOs or international cooperation departments within various institutions. Various stakeholders can be identified in these projects: project coordinator, task manager, national supervisor, project team, steering committee, the beneficiaries, and the population at large. Cultural differences can exist among these stakeholders. Kealey, Protheroe, MacDonald, and Vulpe (2005) gave four reasons why international projects that take place in intercultural settings are complex to initiate and carry out. Three of the reasons are relevant for this study. First, international projects are located in a different cultural setting for at least one of the project partners. In a different cultural context, individual values, organisational structures, and organisational processes may differ, which has major consequences for project management and collaboration between project partners. Second, project partners from different countries can differ substantially in situation, interests, and incentives, which can affect the relationship between the project partners as well as local stakeholders' willingness to change. Third, at least one project partner is less familiar with the political, legal and regulatory, macroeconomic and social environment of the host country. Consequently, the 'environmental scanning function', namely, accurate perceiving and understanding of the environment, is less accurate for this project partner.

Culture in Educational Reform

The first and second reasons addressed by Kealey et al. (2005) pertain to the role of culture in influencing the organisations and stakeholders involved in educational reform. Stephens (2007) defined culture as: "(1) the knowledge and ideas that give meaning to the beliefs and actions of individuals and societies and (2) the ideational tool which can be used to describe and evaluate that action" (p. 29). Culture is a multilevel concept which can be identified at visible and invisible levels (Hofstede, 1980; Spencer-Oatey, 2000; Trompenaars & Hampden-Turner, 1997). According to Dimmock and Walker (2002), societal cultures impact the more explicit organisational cultures. Whereas organisational values, beliefs, and norms can be managed and changed, the deeper underlying values of societies are more permanent. The influence of societal and organisational cultures on educational structures, processes, and practices is particularly emphasised when focusing on educational reform in culturally diverse settings, (Dimmock & Walker, 2000, 2002). Dimmock and Walker (1998) developed a 'cross-cultural comparative framework' which shows the relationships between two levels of culture, societal and organisational, and four interrelated elements of schooling and school-based management, namely, organisational structures, leadership and management processes, curriculum, and teaching and learning. For example, schools in strongly centralised systems differ from schools in more decentralised systems in respect to their organisational structures. Societal and organisational culture can also influence the position, role, leadership style, and power of the principal as well as management processes such as decision making, interpersonal communication, conflict resolution, and staff development. In this respect, Matveev and Nelson (2004) stated that project teams with members from culturally diverse settings are particularly vulnerable to interaction problems, because of differences in stakeholders' perceptions of the environment, motives and intentions of behaviours, and communication norms, along with stereotyping, ethnocentrism, and prejudices. Due to culture, among other reasons, schools can also vary in the goals and purposes of the curriculum, the range of subjects and disciplines, the levels at which the curriculum is offered, and differentiation in the curriculum. Finally, schools can differ in the way teaching and learning activities are conducted. Views of the nature of knowledge, the interaction between the teacher and the student, and teaching methods and approaches are especially culturally dependent (e.g., Den Brok, Levy, Wubbels, & Rodriguez, 2003; Hofstede, 1986; Levy, Wubbels, Brekelmans, & Morganfield, 1997).

Challenges to Accounting for Culture in Curriculum Development

As stipulated in the third reason discussed by Kealey et al. (2005) and shown by Dimmock and Walker (1998), educational reform initiated within the frame of international cooperation is affected by societal culture. Consequently, cultural understanding and reflection is an important condition for success. As curriculum development is often part of reform initiatives, accounting for culture in such curriculum development processes is necessary. Berkvens (2009) mentioned that educational development agendas are highly influenced by Western beliefs and expectations, and that international aid organisations do not take the time to understand cultural dispositions and to develop contextual understanding. As a result, concepts are introduced with the best intentions, but in an inconsiderate and uncoordinated way, leading to poorly implemented and superficially understood concepts. This confirms the need for the environmental scanning function introduced by Kealey et al. (2005). Leyendecker (2008) discussed the interrelation between the larger socio-cultural and political context, and the beliefs, values, and relationships of people influencing curriculum reform and implementation. Referring to reform initiatives in Namibian and South African schools, one of the main reasons for the maintenance of the status quo in these schools was believed to be a misfit between the curriculum development ambitions stimulated by international cooperation and the local educational practices within the cultural context (Chisholm & Leyendecker, 2008). Hence, the environmental scanning function can be extended to a curriculum and classroom level in which societal culture is taken into account.

International Cooperation, Culture, and Curriculum Development

The success of an educational reform supported by international cooperation depends upon an effective synthesis of the culturally shaped needs and context characteristics expressed (e.g., Caddell, 2005; Chisholm & Leyendecker, 2008; Hopkins, 2002; Rogan & Grayson, 2003), and effective curriculum development in which stakeholders understand the influences of culture on the curriculum development process. As Kouwenhoven (2003) strikingly stated: "Culture is an aspect that pervades substantive aspects of the curriculum as well as the processes of design, development and implementation" (p. 137). Nevertheless, the influence of culture on curriculum development processes has been little studied empirically. According to Rogers, Graham, and Mayes (2007), changes in design models and methods are needed to facilitate greater sensitivity and responsiveness to cultural differences.

In the study reported in this chapter is an investigation of how culture affects curriculum development processes in the context of international curriculum development projects. Better insight into cultural implications for curriculum development processes, as addressed, can support the development of theories and strategies aiming at greater sensitivity and responsiveness to culture. The study was conducted with regard to an international cooperation programme (NPT: Netherlands Programme for Institutional Strengthening of Post-secondary Education and Training Capacity), consisting of various projects, between The Netherlands and Ghana to strengthen the capacity of Ghanaian post-secondary education and training organisations. Due to the involvement of two countries with different societal cultures and a focus on educational reform through curriculum development, the programme seemed to be exemplary for studying the role of culture in curriculum development processes.

Research Question

To facilitate culturally sensitive curriculum development, this study aimed at clarifying the influence of culture on curriculum development processes in the context of international cooperation. Based on this research objective, the main research question was defined as:

> How do cultural factors influence curriculum development processes in the context of international cooperation projects?

This main research question was operationally defined and answered in five sub-studies. The first sub-study addressed the *development of a framework* for culturally sensitive curriculum development in which the main components of educational reform are integrated. The development of such a framework could more explicitly facilitate the identification of cultural influences on curriculum development processes in international cooperation projects and could conceptually support the analysis of these factors. In three more specific sub-studies, the framework was applied to identify the cultural influences on the process of developing a curriculum for a professional development programme for polytechnic Heads of Department (PDHoD). This development process was part of a project in the NPT programme to enhance leadership and management capacity in Ghanaian polytechnics. The curriculum was designed and implemented by a Ghanaian and a Dutch curriculum specialist who were members of a broader project team, consisting of curriculum specialists, educational change facilitators, and ICT support staff from Ghana and The Netherlands. Whereas sub-study 2 focused on the influence of culture on the *curriculum development activities* conducted, sub-study 3 addressed the cultural influences on *conditions* created during the curriculum development process. Sub-study 4 particularly focused on the *immediate learning outcomes* of the Heads of Department who participated in the professional development programme and the *transfer* of these learning outcomes to the polytechnic context. In the fifth sub-study, the developed framework was applied to address the influence of culture on curriculum development activities conducted and conditions created in other international cooperation projects within the NPT programme between Ghana and The Netherlands.

Design of the Studies

A case study approach was adopted for the overall design of the studies. Yin (2003) noted that case studies are appropriate to answer ‘how’ and ‘why’ questions about a contemporary set of events. For purposes of triangulation, different research instruments were used, such as questionnaires, interviews, document analysis, and observations.

Development of a Framework

Prior to the case studies, the *first sub-study* focused on the development of a framework for culturally sensitive curriculum development that can be used as an instrument to analyse and identify cultural influences on curriculum development processes in international cooperation projects. Based on analysis of the literature and experts' reviews, a framework was developed that included as a component the 'curriculum development process', subdivided into curriculum development activities as part of context analysis, design by iteration, sustainable implementation, and conditions for curriculum development as part of creation of ownership, and project management. The framework also included 'practice' as a component, representing the educational context, and the component of 'cultural frame of reference', concerning four dimensions of culture: high-low power distance, collectivism-individualism, high-low context, and polytime-monotime.

Single-Case Study

Next, the framework was applied to analyse a curriculum development process in the context of the NPT programme between Ghana and The Netherlands. In the *second sub-study*, the developed framework was used to identify influences of culture on curriculum development activities concerning the professional development programme for Heads of Department (PDHoD) in polytechnics in Ghana. More specifically, the cultural influences on the curriculum development activities associated with context analysis, design by iteration, and sustainable implementation were analysed. Data were collected by means of interviews with the curriculum specialists, observations, and document analysis.

The *third sub-study* focused on the identification of cultural influences on the creation of conditions for the development of the professional development programme for Heads of Department in Ghanaian polytechnics. In particular, the developed framework was used to analyse and identify cultural influences on the development of conditions as part of creation of ownership and project management. As in sub-study 2, data collection involved interviews with the curriculum specialists, observations, and document analysis.

In the *fourth sub-study*, the influences of culture on the outcomes of the professional development programme for Heads of Department and the transfer of these outcomes to the polytechnics were analysed and identified by applying the developed framework and were related to Guskey's (2000) model for evaluating professional development programmes. Data were collected through interviews with the Heads of Department, questionnaires, and observations.

Multiple-Case Study

A multi-case study was used to analyse other curriculum development processes in the context of the international cooperation programme between Ghana and The Netherlands. In the *fifth sub-study,* based on the outcomes of the sub-studies 2 and 3, curriculum development activities and conditions as part of five other projects in the NPT programme were analysed for cultural influences by using the developed framework, and these outcomes were compared with the outcomes of the single-case study. Data were collected by means of interviews with project coordinators and project team members.

Main Findings

As already mentioned, the framework developed in the first sub-study consisted of three components, the curriculum development process, practice, and cultural frame of reference. The *curriculum development process* component included curriculum development activities as part of context analysis, design by iteration, and sustainable implementation. If contextual factors are carefully analysed, iterations of designing, implementation, and evaluation activities are included, and strategies are developed to embed the curriculum in the school context, coherence between the curriculum and the cultural context can be ensured. The conditions as part of creation of ownership and project management were also included in the curriculum development process component in the framework. By involving stakeholders in curriculum development activities and effective management of the overall curriculum development process, coherence between stakeholders' perceptions can be created, as well as favourable process conditions. In the framework, the *practice* component represented the educational context. School structures, educational processes, and stakeholders have their influence on and will be affected by the curriculum development process. The *cultural frame of reference* framework component included cultural characteristics that might affect curriculum development processes and educational practices. Four dimensions of national culture were selected that were expected to affect curriculum development processes and the implementation of curriculum development outcomes in the context within which educational improvement was considered necessary: high-low power distance, collectivism-individualism, high-low context, and polytime-monotime. Hofstede's (2001) dimension of 'high-low power distance' deals with the extent to which people in less powerful positions within a society accept and expect that power is unequally distributed. The dimension of 'collectivism-individualism' was defined by Hofstede as the extent to which individuals are part of strong, cohesive groups in a society. The two other cultural dimensions were described by Hall (1976). The dimension of 'high-low context orientation' deals with the extent to which information is included in communication messages. The dimension of 'poly(chronic)-mono(chronic) time orientation' deals with the ways in which people handle time. Each dimension was characterised by its two opposing end points, reflecting ideal types. Both ends of the cultural dimensions were included in the framework and the dimensions were presented as unrelated to any curriculum development activity or condition.

The conceptual framework for culturally sensitive curriculum development was used in the subsequent sub-studies to facilitate the identification of cultural influences on the development of the PDHoD curriculum and on other curriculum development processes as part of international cooperation projects between Ghana and The Netherlands. The outcomes of the second sub-study indicated that the curriculum development activities conducted in the development process for PDHoD were congruent with the activities included in the conceptual framework (i.e., context analysis, design by iteration, and sustainable implementation); they were strongly impacted by Hofstede's (2001) cultural dimensions of power distance and collectivism-individualism and were impacted to a limited extent by Hall's (1976) cultural dimensions of context and time. Both ends of the cultural dimension of power distance were identified in the development activities related to context analysis; under design by iteration, the two ends of the dimensions of power distance and collectivism were identified, as well as low context and polytime; concerning sustainable implementation, both ends of the power distance and collectivism dimensions characterised the activities. This sub-study revealed cultural differences within the curriculum development activities. Whereas the curriculum specialists and broader project team aimed at developing a PDHoD characterised by low power distance (fitting needs), collectivism (group work, peer support), and individualism (self-reflection, individual responsibility), Ghanaian stakeholders were influenced in PDHoD development and in the polytechnic context by high power distance (teacher-centred approach, hierarchy in polytechnics), individualism (own interests), and collectivism (not taking individual initiatives). To reinforce the intentions of the curriculum specialists, the PDHoD was adjusted and outside support activities were conducted, characterised by high-low power distance (anticipating hierarchy, sharing responsibilities and demand-driven support) and collectivism-individualism (increased collaboration, self-reflection and initiative). The outcomes of the sub-study substantiated the need to account for culture in curriculum development activities, and the value of the conceptual framework for identifying and analysing aspects of culture in curriculum development processes.

How culture affected the creation of conditions for the development of PDHoD was investigated in the next sub-study. The conclusion from sub-study 3 was that the conditions as part of building ownership and managing the project were congruent with the conditions included in the framework (i.e., creation of ownership and project management) and were strongly influenced by all four cultural dimensions and their end points. As in sub-study 2, cultural differences that sometimes caused conflicts and misunderstandings were identified. The intended conditions were characterised by low power distance (involvement by local stakeholders, shared responsibility) and collectivism (strong networks), but the Ghanaian stakeholders and project partner experienced influences of high power distance (top-down approach, strict hierarchy in polytechnics) and individualism (individual allowances, individual work) in the project or educational context, which decreased their involvement and put pressure on the project management. Furthermore, the Dutch project partner was more used to low context communication strategies (communication on paper) and monotime (strict planning), in contrast to the high context strategies (face-to-face communication) and polytime (flexible planning) preferences of the Ghanaian project partner and stakeholders. These differences obstructed adequate communication between the project partners and project management. Different types of strategies were developed by the broader project team to support the conditions for the development of PDHoD, which could be characterised by low power distance (shared responsibility), collectivism (strengthened collaboration), low context (communication on paper), and high context (face-to-face communication). Notwithstanding, some cultural dissimilarities remained challenging for the project team to cope with, which highlighted the necessity to develop strategies to deal with cultural differences manifesting in curriculum development conditions.

Results of the fourth sub-study led to the conclusion that all four cultural dimensions and their end points affected the outcomes of the PDHoD as well as their transfer. Cultural similarities were observed between the PDHoD and the educational needs and preferences of the Heads of Department (HoDs), which resulted in positive perceptions of the PDHoD, learning results as intended, and intentions to transfer the learning outcomes. The HoDs appreciated characteristics of the programme identified as low power distance (demand-driven, participation), individualism (analysis and reflection strategies), collectivism (team building and collaboration), and monotime (planning). These cultural implications were also identified in HoDs' learning results and intentions to transfer the learning outcomes. In addition, with regard to the cultural dimension of context, the HoDs appreciated characteristics of high context (support to contextualise learning) in the PDHoD, while their learning results included influences of low context (transparency).

However, the existing norms, structures, and procedures in the polytechnics, and HoDs' and staff members' attitudes influenced the concrete implementation of the PDHoD and corresponded in a limited way with what was learned in the PDHoD. This led to a cultural mismatch between the aims of the PDHoD and HoDs' working situation and challenged the transfer of the learning outcomes of the PDHoD to educational practices in the polytechnics. The HoDs especially criticised characteristics of the programme identified as high power distance (teacher-centred), collectivism (showing off), individualism (insufficient individual benefits), high context (need for more local workshop leaders), and polytime (loose time management). Some of the cultural influences characterizing these critical notes could also be identified in the polytechnic context in relation to HoDs' transfer experiences and perceptions of the organisational support provided, such as high power distance (high dependency) and individualism (focus on individual interests). Tendencies of HoDs and staff members themselves, identified as collectivism (preference for team work and group decisions), high context (combining work with personal relationships), and polytime (postponing appointments), also hindered the transfer of learning outcomes to the polytechnic context. Strategies to improve the PDHoD were suggested by the HoDs, which indicated attention to high-low power distance (strengthening consultation with stakeholders, provision of steering,), and collectivism (stimulating collaboration); the HoDs even developed their own strategies, identified as high power distance (coping with hierarchy) and high context (avoiding explicit expressions).

To be able to compare the process of developing PDHoD with other curriculum development processes, the fifth sub-study included five international cooperation projects within the NPT programme between Ghana and The Netherlands (including the project in which the PDHoD was developed). Based on the results of this sub-study, it could be concluded that all cultural dimensions and their end points strongly influenced the curriculum development in the five international cooperation projects. Concerning activities under context analysis, the outcomes of this sub-study confirmed the findings of sub-study 2, and additionally underscored the influence of high power distance (decision making by Dutch project partner) in needs analysis activities as part of context analysis. In relation to design by iteration, not all previous findings were supported. In contrast to what was found in the earlier sub-studies, the influence of collectivism (emphasis on group work) was not explicitly underscored in the other curriculum development projects, while the influence of high context (focus on friendly relations) was additionally identified. The cultural influences identified in the process of developing the PDHoD concerning the activities to create conditions as part of creation of ownership were also identified in this sub-study, and complemented with influences of polytime (less structured way of working) and monotime (structured way of working). The cultural influences identified concerning project management activities were to a certain extent similar to the outcomes of the previous sub-studies, but influences of Low-High Context and Collectivism were not found. Differences between the outcomes of sub-studies 2 and 3 and the outcomes of this sub-study could be explained by differences in the design of the other international curriculum development projects, by the specific focus of the sub-study, and by the fact that the projects were not analysed as in as comprehensive, specific, and in-depth a way as in the earlier sub-studies.

Conclusion and Discussion

As a result of this study, a conceptual framework for culturally sensitive curriculum development was developed and greater understanding was gained about the role of culture in curriculum development processes in international cooperation projects. In the following sections the research findings are reflected upon.

Conceptual Framework: Additions and Changes?

The conceptual framework for culturally sensitive curriculum development that was developed in the first sub-study proved to be valid, usable, comprehensive and generic. The empirical sub-studies produced evidence for the three components included in the framework and their underlying concepts. The curriculum development activities and conditions as part of the *curriculum development process* component were all identified in the curriculum development process for PDHoD. Since various cultural influences affected the curriculum development activities, conditions, and outcomes, the importance of making the curriculum development process more culturally sensitive was stressed.

Concerning the *cultural frame of reference* component, evidence was found for the relevance of each of the four dimensions in analysing curriculum development processes for cultural influences. The selection of two out of five Hofstede's dimensions was justified by the literature and experts' reviews and proved to be useful to keep focus in the study. Furthermore, Hall's dimensions turned out to be very relevant, especially to gain understanding about the influence of culture on activities as part of creation of ownership and project management. The exclusion of assumptions in the framework proposing possible relations between the cultural dimensions and curriculum development activities was supported by this study. The inclusion of assumptions would have limited the usability and applicability of the conceptual framework and would have narrowed the scope of the analysis. To illustrate, Hofstede (2001) categorised Ghana, among some other countries, under the West African Region and concluded that Ghana could be characterised as high power distance and collectivism, and The Netherlands as low power distance and individualism. In this study, the conceptual framework provided the possibility of investigating these cultural influences on curriculum development processes much more specifically, comprehensively, and subtly. Based on the experiences gained in this study, further adaptation of the operational definition of the cultural dimensions seems to be worthwhile to make these definitions more concrete and distinctive. Furthermore, findings from this study suggest that influences of the power distance and collectivism dimensions may coincide in curriculum development processes and educational contexts, as well as influences of the collectivism-individualism dimension and Hall's context and time dimensions. Although this would correspond with the findings of other studies (e.g., Korac-Kakabadse, Kouzmin, Korac-Kakabadse, & Savery, 2001; Schwartz, 1994; Triandis & Gelfand, 1998; Zhu, Nel, & Bhat, 2006), more research is needed to support these beliefs.

Concerning the *practice* component, the application of Guskey's (2000) levels of professional development evaluation together with the framework of culturally sensitive curriculum development, provided opportunities to identify influences of culture on the learning outcomes and their transfer in educational practice. Therefore, the conceptual framework can be extended by integrating Guskey's levels of professional development evaluation. Particularly when the curriculum development process aims at developing a professional development programme, an extended conceptual framework can clarify how culture affects the outcomes of the professional development programme and the transfer of these outcomes to educational practice. This may provide better understanding about the influence of culture on the effectiveness of curriculum reform.

Culture and Curriculum Development in International Cooperation Projects: Outcomes and Guidelines

This study aimed at identifying how cultural factors influence curriculum development processes in international cooperation projects. The main research question of the study was stated as: "How do cultural factors influence curriculum development processes in the context of international cooperation projects?" Based on the study findings arising in the context of international cooperation between Ghana and The Netherlands, evidence was obtained that influences related to the cultural dimensions of power distance, collectivism-individualism, context, and time strongly affected activities undertaken to develop curricula, to create the conditions for curriculum development, and to implement the curriculum development outcomes in practice. This overall conclusion strengthens the need to account for culture in curriculum development processes in the context of international cooperation projects. Analysis of the processes to develop PDHoD and other curricula in the international cooperation projects between Ghana and The Netherlands provided insights into the way in which the four cultural dimensions and their end points affected curriculum development. In this section, the overall study outcomes are presented and guidelines are given for how to account for culture in curriculum development processes in international cooperation.

Curriculum Development Activities

Activities as part of context analysis were strongly influenced by the power distance dimension, but subsequent curriculum activities as part of design by iteration and sustainable implementation were also affected by the two ends of the collectivism dimension and to a certain extent by the context and time dimensions. Hence, the influence of culture on stakeholders' values and on the educational context in which the curriculum development activities were conducted and in which the curriculum would be implemented became more obvious during the curriculum development process. Consequently, although the activities to develop the curricula were aimed at meeting the needs of the Ghanaian stakeholders, the execution of curriculum development activities and the implementation of the curricula in the educational practice did not always work out as intended. Based on these outcomes, the following guidelines are suggested:

- Conduct extensive context analysis activities at an early stage of the curriculum development process, aimed at identifying cultural influences that could affect the curriculum development activities and the implementation of curricula in the educational contexts at a later stage (guideline 1)
- Interpret and analyse the outcomes of stakeholders' needs analysis as part of context analysis activities from a cultural point of view and in relation to the cultural educational contexts, to avoid having demand-driven activities for curriculum development that do not fit the contexts for which the curricula are intended (guideline 2)
- Conduct formative evaluation activities as part of design-implementation-evaluation iterations throughout curriculum development processes to continually create opportunities for adjusting the curriculum development activities and their outcomes to cultural influences on stakeholders' preferences and on the educational contexts (guideline 3)

The stakeholders involved in development of the PDHoD were given suggestions by the project teams to foster sustainable implementation of the curriculum in their own practices. The involvement of a local curriculum developer also helped the stakeholders to adapt the curriculum to their cultural educational context. Besides this, the project team developed strategies for themselves to deal with the cultural influences on the curriculum development activities and outcomes. These adjustment strategies were characterised by the power distance and collectivism dimensions and anticipated the cultural, educational context, the values of the project partners, and the curriculum development intentions. Based on these outcomes, the following guidelines are formulated:

- Facilitate local stakeholders in their activities to implement curricula sustainably in cultural educational contexts (guideline 4)
- Develop adjustment strategies anticipating the role of culture in curriculum development processes, outcomes, and educational contexts to facilitate sustainable curriculum implementation within educational contexts (guideline 5)
- Strongly involve local curriculum developers in curriculum development processes to increase the cultural relevance and appropriateness of curricula, and to facilitate sustainable curriculum implementation within cultural educational contexts (guideline 6)

Conditions for Curriculum Development

Conditions as part of creation of ownership and project management were influenced by all cultural dimensions. Concerning the power distance and collectivism dimensions, differences existed between the intended conditions the project team strived for and the perceived conditions in the project or educational context. The dimensions of context and time also strongly influenced the conditions for curriculum development. Differences on these dimensions in project management and communication strategies between the Dutch project partner on the one hand and the Ghanaian project partner and stakeholders on the other hand, decreased stakeholders' and project partners' ownership and put pressure on project management as conditions for curriculum development processes. Based on these outcomes, the following guidelines are formulated:

- Conduct extensive context analysis activities at an early stage of the curriculum development process to identify cultural influences on stakeholders' preferences and on educational contexts, which could affect project management activities and stakeholders' ownership necessary for effective curriculum development activities and sustainable implementation of developed curricula in the educational contexts (guideline 7)
- Clarify the expectancies and preferences concerning the division of tasks and responsibilities, communication strategies, time perceptions, and financial remuneration between the project partners at an early stage of the curriculum development process and analyse them for cultural influences to avoid conflicts and misunderstandings during the curriculum development process (guideline 8)

Anticipating that cultural influences of the power distance, collectivism, and context dimensions would affect project partners' common intentions, individual preferences, and the educational context, the project team developed and applied different types of strategies. These strategies aimed at supporting the curriculum development activities and dealing with the cultural differences experienced in relation to the curriculum development conditions. Nevertheless, some cultural dissimilarities remained challenging for the project team to cope with and impacted the whole curriculum development process. Based on these outcomes, the following guidelines are formulated:

- Create extensive opportunities at an early stage of the curriculum development process to get to know the project partners' cultural backgrounds, to reach agreement on strategies to deal with cultural differences, and to build joint partnerships as conditions for curriculum development (guideline 9)
- Be willing, open-minded, and culturally-sensitive about understanding and appreciating differences in educational contexts and in the behaviour of project team members and stakeholders in order to adequately support curriculum development (guideline 10)
- Develop adjustment strategies anticipating the role of culture in the preferences of project partners and in the educational contexts, to facilitate curriculum development processes and to create conditions for curriculum implementation in educational contexts (guideline 11)

Outcomes of Curriculum Development

Cultural similarities were observed between the developed curriculum and stakeholders' educational needs and preferences on the dimensions of power distance, collectivism, and time. This resulted in positive curriculum perceptions, learning results as intended, and intentions to transfer the learning outcomes. However, not all cultural influences identified in stakeholders' attitudes and in the educational context as related to one of the ends of the power distance, collectivism, context, and time dimensions corresponded with what was learned in the curriculum. For this reason, the transfer of the learning outcomes to the educational context was perceived as challenging by the local stakeholders. However, the project teams were limited in their possibilities for supporting the implementation of the curriculum. Based on these outcomes, the following guidelines are suggested:

- Conduct context analyses and formative evaluation activities as part of design by iteration in early stages of the curriculum development process, focusing on cultural influences on stakeholders' perceptions and transfer experiences, to create a match between the curriculum and stakeholders' values, needs and educational contexts (guideline 12)
- Create opportunities to involve local stakeholders as developers, experts, and/or instructors in curriculum development processes to ensure the effectiveness of the developed curriculum in the cultural educational context (guideline 13)
- Facilitate local stakeholders during the curriculum development process to create transfer and problem-solving conditions that support the implementation of curriculum development outcomes in the cultural educational contexts (guideline 14)

Recommendations

This study made a contribution to existing knowledge and produced instruments that are available for project coordinators and project team members, especially curriculum developers, who are involved in curriculum development endeavours as part of international cooperation projects. In this concluding section, suggestions are given for increasing the cultural sensitivity of their curriculum development efforts.

Application of the Conceptual Framework

By applying the conceptual framework for culturally sensitive curriculum development, curriculum developers are facilitated in better understanding culture and cultural mismatches in curriculum development processes, and in improving on-going and future curriculum development endeavours. The conceptual framework provides a useful tool to visualise the cultural sensitivity of curriculum development in international cooperation, to analyse curriculum development processes for cultural influences, and to discuss cultural misunderstandings among the project partners. When culture becomes more concrete and apparent, different types of strategies can be developed to anticipate the identified cultural influences and to increase the cultural sensitivity of curriculum development processes and curricula before problems occur. By applying Guskey's (2000) levels of professional development evaluation together with the framework, cultural challenges in or mismatches between the professional development programmes and the local cultural context may be revealed. More cultural awareness and mutual understanding can also help to avoid conflicts between the project partners.

Importance of Curriculum Development Activities and Conditions

Based on the outcomes of this study and the guidelines provided to account for culture in curriculum development processes in international cooperation projects, project teams can critically analyse and reflect on culture right from the beginning of the project. By means of extensive context analysis activities, opportunities can be created to become acquainted with the culturally shaped organisational structures, processes, and contexts. Stakeholders' and project partners' norms, values, and preferences involved in the curriculum development process can also be elicited. Furthermore, time and patience are needed to jointly identify and reflect on cultural influences that may affect upcoming activities to develop curricula, conditions for curriculum development, and the implementation of curricula in the educational context. Accounting for culture in early phases of the project will pay off.

Obviously, not all cultural implications can be foreseen. Integrating formative evaluation activities into the curriculum development process can help to identify cultural differences, mismatches, and misunderstandings during the development process, and can offer possibilities for developing strategies to improve and adjust the curriculum development activities and outcomes. Moreover, international cooperation organisations and other institutions outside the schools can support and facilitate the implementation of curriculum reforms and the transfer of professional development programmes in local, culturally shaped contexts.

Involvement of Local Stakeholders, Experts, and Researchers

Characteristics of the cultural context can be especially hard to ascertain for foreign project team members, while local stakeholders understand these influences by nature. Therefore, to be able to anticipate the influence of culture in the curriculum development process, to ensure a good fit between the developed curricula and the educational contexts, and to create stakeholder acceptance, strong involvement of local stakeholders (i.e., school managers, teachers, and students) is recommended.

Additionally, collaboration among project members and experts who have intercultural experience and skills in international cooperation projects is strongly recommended. Investments in team building seminars, on-site work-related visits, and long-term stays can contribute to the development of project team members' intercultural competences. Furthermore, these investments may stimulate project team members to increase their interpersonal and cross-cultural awareness and to keep learning from each other and each other's contexts.

References

Berkvens, J. B. Y. (2009). *Developing effective professional learning in Cambodia*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Caddell, M. (2005). Listening to local voices? International targets and decentralised education planning in Nepal. *International Journal of Educational Development, 25*(4), 456–469.

Chisholm, L., & Leyendecker, R. (2008). Curriculum reform in post-1990s sub-Saharan Africa. *International Journal of Educational Development, 28*(2), 195–205.

Den Brok, P., Levy, L., Wubbels, T., & Rodriguez, M. (2003). Cultural influences on students' perceptions of videotaped lessons. *International Journal of Intercultural Relations, 27*(3), 355–374.

Diallo, A., & Thuillier, D. (2004). The success dimensions of international development projects: The perceptions of African project coordinators. *International Journal of Project Management, 22*(1), 19–31.

Dimmock, C., & Walker, A. (1998). Comparative educational administration: Developing a cross-cultural conceptual framework. *Educational Administration Quarterly, 34*(4), 558–595.

Dimmock, C., & Walker, A. (2000). Developing comparative and international educational leadership and management: A cross-cultural model. *School Leadership & Management, 20*(2), 143–160.

Dimmock, C., & Walker, A. (2002). School leadership in context: Societal and organisational cultures. In T. Bush & L. Bell (Eds.), *The principles and practice of educational management* (pp. 70–85). London: Paul Chapman Publishing.

Fullan, M. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Gervedink Nijhuis, C. (2012). *Culturally sensitive curriculum development in international cooperation*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Hall, E. T. (1976). *Beyond culture*. New York: Anchor Press/Doubleday.

Hofstede, G. (1986). Cultural differences in teaching and learning. *International Journal of Intercultural Relations, 10*(3), 301–320.

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations* (2nd ed.). Thousand Oaks, CA: Sage.

Hofstede, G. H. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills, CA: Sage.

Hopkins, D. (2002). Educational innovation: Generic lessons learned from (a) regional practice. In A. Thijs, L. de Feiter, & J. Van den Akker (Eds.), *International learning on education reform: Towards more effective ways of cooperation* (pp. 27–54). Amsterdam: Vrije Universiteit.

Kealey, D. J., Protheroe, D. R., MacDonald, D., & Vulpe, T. (2005). Re-examining the role of training in contributing to international project success: A literature review and an outline of a new model training program. *International Journal of Intercultural Relations, 29*(3), 289–316.

Korac-Kakabadse, N., Kouzmin, A., Korac-Kakabadse, A., & Savery, L. (2001). Low- and high-context communication patterns: Towards mapping cross-cultural encounters. *Cross Cultural Management: An International Journal, 8*(2), 3–24.

Kouwenhoven, W. (2003). *Designing for competence: Towards a competence-based curriculum for the Faculty of Education of the Eduardo Mondlane University*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Levy, J., Wubbels, T., Brekelmans, M., & Morganfield, B. (1997). Language and cultural factors in students' perceptions of teacher communication style. *International Journal of Intercultural Relations, 21*(1), 29–56.

Leyendecker, R. (2008). *Curriculum reform in Sub-Saharan Africa: Opportunities and obstacles*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Matveev, A. V., & Nelson, P. E. (2004). Cross cultural communication competence and multicultural team performance: Perceptions of American and Russian managers. *International Journal of Cross Cultural Management, 4*(2), 253–270.

Plomp, T., & Thijs, A. (2002). Priorities and strategies for improvement of education. In A. Thijs, L. de Feiter, & J. Van den Akker (Eds.), *International learning on education reform: Towards more effective ways of cooperation* (pp. 71–90). Amsterdam: Vrije Universiteit.

Rogan, J. M., & Grayson, D. J. (2003). Towards a theory of curriculum implementation with particular reference to science education in developing countries. *International Journal of Science Education, 25*(10), 1171–1204.

Rogers, P. C., Graham, C. R., & Mayes, C. T. (2007). Cultural competence and instructional design: Exploration research into the delivery of online instruction cross-culturally. *Educational Technology Research and Development, 55*(2), 197–217.

Schwartz, S. H. (1994). Beyond individualism/collectivism: New cultural dimensions of values. In U. Kim, H. C. Triandis, Ç. Kagitçibasi, S.-C. Choic, & G. Yoon (Eds.), *Individualism and collectivism: Theory, method, and applications* (pp. 85–119). Thousand Oaks, CA: Sage.

Spencer-Oatey, H. (2000). *Culturally speaking: Managing rapport through talk across cultures*. London: Continuum.

Stephens, D. (2007). *Culture in education and development: Principles, practice and policy*. Oxford, UK: Symposium Books.

Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt, Brace, & World.

Thijs, A., de Feiter, L., & Van den Akker, J. (Eds.). (2002). *International learning on education reform: Towards more effective ways of cooperation*. Amsterdam: Vrije Universiteit.

Triandis, H. C., & Gelfand, M. J. (1998). Converging measurement of horizontal and vertical individualism and collectivism. *Journal of Personality and Social Psychology, 74*(1), 118–128.

Trompenaars, F., & Hampden-Turner, C. (1997). *Riding the waves of culture: Understanding cultural diversity in business*. London: Nicholas Brearley.

Van den Akker, J. (2003). Curriculum perspectives: An introduction. In J. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Wedman, J., & Tessmer, M. (1993). Instructional designers' decisions and priorities: A survey of design practice. *Performance Improvement Quarterly, 6*(2), 43–57.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.

Zhu, Y., Nel, P., & Bhat, R. (2006). A cross cultural study of communication strategies for building business relationships. *International Journal of Cross Cultural Management, 6*(3), 319–341.

Part II
Analysis: Editorial Introduction

Needs Analysis and Assessment: A Prerequisite for Adoption and Implementation

In order to design curriculum or instruction it is necessary to analyze the problem at hand with relevant stakeholders. A needs and context analysis are therefore the first step in the design process, as they contribute to better understand the characteristics of the problem, the stakeholders and the system in which these operate. The first chapter of this section by Edward Akomaning on stakeholder's involvement in needs assessment reports a study that used a systematic needs and context analysis to examine the perceptions of major stakeholders (teachers, industry and students) about the links between vocational education institutions and the hospitality industry in student internship programmes. In particular, the chapter focuses on the way the needs and context analysis was used to inform the design by a team of faculty members of a manual to guide student internship. The way the needs and context analysis increased ownership of student internship among relevant stakeholders is discussed.

Teachers' understanding of curriculum reform and their ownership regarding the reform are expected to be promoted by having them fulfil the role of designer. However, despite these positive expectations about teachers who take an active designer role, several studies have shown that teachers lack the knowledge and skills needed for proper curriculum design. The assumption underlying the study reported in the chapter by Tjark Huizinga, Nienke Nieveen and Adam Handelzalts is that teachers need support during collaborative design in order to enhance their curriculum design expertise. This chapter presents and discusses the support offered to promote teachers' curriculum design expertise during a collaborative curriculum design project conducted within the frame of a national reform in the Netherlands.

The third chapter in this section by Ayoub Kafyulilo and Petra Fisser addresses the development of TPACK (technological pedagogical content knowledge) in science and mathematics teacher education. They took as a starting point the case of Tanzania's efforts to introduce technology into education. Despite several government initiatives, technology did not become integrated in educational practice. A main reason is that teachers do not embrace the use of technology in their teaching. The study was initiated to design, implement and evaluate a professional development arrangement aimed at promoting teachers' use of technology in their teaching practice. The study started with a 'proof of concept' study. Based on experiences in Ghana and Kuwait, a professional development arrangement was developed that incorporated 'learning technology by design' to prepare pre-service science and math teachers for using technology in their teaching. The experiences from this study informed the design of a professional development arrangement for practicing science teachers. The iterative design, implementation and evaluation of the professional development arrangements are presented and discussed.

Chapter 6
Improving Student Internship Through Collaborative Curriculum Design: Needs and Context Analysis to Inform the Design Process

Edward Akomaning

Introduction

Ghanaian polytechnics are confronted with major obstacles. These obstacles can be linked to an episodic relationship between the polytechnics and industries (Gervedink Nijhuis, Bakah, & Akomaning, 2009), the haphazard organisation of student internship (Effah, 2005), irregular revision of curricula (Effah, 2001), and curricula that are supply-driven instead of demand-driven (Akyeampong, 2010). Consequently, many polytechnic graduates cannot find appropriate jobs in industry, let alone establish their own businesses after graduation (Akyeampong, 2010; Japan International Cooperation Agency [JICA], 2001). According to the JICA (2001) report, an estimated 30% of polytechnic graduates were unemployed, and the reason assigned was inadequate acquisition of employable skills. There is a growing public concern about the quality of polytechnic graduates (Alagaraja & Arthur-Mensah, 2013).

One main problem in the polytechnic system in Ghana is its inability to facilitate effective internships for students. Internship refers to a form of workplace learning (Levesque, Lauen, Teitelbaum, Alt, & Librera, 2000) where students are sent to various organisations. It is a vital component of higher professional education. It allows students to gain valuable, marketable skills to place on their resumes. Despite the availability of good training, employers place a higher priority on actual experience in acquiring technical skills. Therefore, no matter how well-trained he or she might be, a worker without practical, hands-on work experience may not be consid-

E. Akomaning (✉)
Institute for Educational Planning and Administration, University of Cape Coast, Cape Coast, Ghana
e-mail: eakomaning@ucc.edu.gh

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_6

ered for most jobs involving newly-acquired technical skills (Carlin & Manson, 2007). This underscores the need for training programme elements, such as internships, that provide training in a hands-on format that teaches technical skills as they would be used on the job. The polytechnics in Ghana lack well-designed curriculum materials as well as coherence in the curriculum for student internship. Effah (2005) describes the internship situation as unsystematic and unstructured, partly because there is no clear curriculum for students, industry personnel and teachers to follow during the internship.

The purpose of the present study was to contribute to an improved curriculum for student internship through the involvement of major stakeholders (teachers, industry and students) in the (re-)design of student internship in the Hotel Catering and Institutional Management (HCIM) programme in Ghanaian polytechnics. This study presents a context and needs analysis that was carried out to analyse the stakeholders' perceptions of the links between the educational institution (i.e., the polytechnic) and the hospitality industry where students go for internship, in order to inform the curriculum design team.

Context of the Study

The context of this study is the Department of Hotel Catering and Institutional Management (HCIM), which is responsible for training students to assume managerial or supervisory roles in the hospitality industry in Ghana and beyond. The HCIM programme is a 3-year tertiary programme that commenced in 1993. Entrants into the programme are predominantly those who have successfully completed the Home Economics programme at their senior secondary school. Successful students graduate with award of the HND (Higher National Diploma certificate in hospitality management. Teaching and learning in the HCIM programme are supposed to be a blend of theoretical and practical lessons. In order to fulfil this mandate, internship programmes are organised for students in which they apply to industries of their choice. Internship programmes occur in two sessions throughout the 3-year programme. Each session spans a period of 3 months at the end of every academic year. So, in all, students are supposed to be at internships for at least 6 months out of the entire study period of 3 years. These internship periods are supposed to be supervised by both polytechnic educators and industry representatives. In order to facilitate the internship programmes, each polytechnic has an Industrial Liaison Unit, whose primary responsibility is to ensure that students have places to carry out an internship.

Theoretical Underpinnings

Conceptualisation of Student Internship Practices

Internship is considered to be an opportunity to integrate career-related experiences into an education programme by having students participate in planned and supervised work (Bakar, Harun, Yusof, & Tahir, 2011). It is a temporary position with an emphasis on workplace learning, usually for a fixed period of time before graduation. According to Billett (2001), such an experience, learning through participating in work, can be understood in terms of how the workplace supports or inhibits individuals' engagement in work activities and access to both direct and indirect guidance. Hence, internships need to be conceptualised more clearly as authentic workplace learning environments (Blokhuis & Nijhof, 2008) through which the industry's contributions can be best organised to assist the learning required of the intern (Billett, 2006). Without the identification, conceptualisation and acknowledgement of an internship curriculum, internships will remain misunderstood and de-legitimised.

Internship is often viewed as a situation that is beneficial for the intern, the educational institution and the intern's employer (Borkowski, 2008; Divine, Linrud, Miller, & Wilson, 2007). These mutual benefits, nevertheless, cannot be guaranteed, because the success or failure of the internship depends largely on the way the various stakeholders collaborate in its implementation process.

Four conditions have been found to be essential for effective student internships:

Collaboration Collaboration between the educational institution, the industry and the student is essential for successful internship practices (Clark, 2003; Schappert 2005). These three parties need to agree on the conditions of the internship, the responsibilities of each party, and the reporting requirements. The formalisation of links between industry and the polytechnics will foster collaboration. Effective collaboration between the industry and the educational institute prevents internships that result in students performing boring and irrelevant tasks, with limited or no contribution to their learning (Johnston, 2008). Relevant internship experiences prepare students to feel confident at the start of their professional career (Christou, 1999). Internship therefore plays a vital role in student learning in industry. Thus, a well-organised internship will help students to transit smoothly from school to industry (Carlin & Manson, 2007). The third party, the students, also need to understand what the educational institution and the industry might expect from them and how they will be treated by their employer and the employees. Collins (2001) found that interns felt that the attitude of their supervisor was sometimes negative, that employees and interns did not interact well and that the environment was sometimes uncomfortable and hectic, with too few responsibilities and opportunities for learning.

Placements Divine et al. (2007) distinguished between managed and unmanaged arrangements for student internships. In managed internships, schools are responsible for student internships. They cater for enough internship places; it often implies that students are assigned an internship place. In unmanaged internships, students are expected to find themselves an internship place. The latter option is pretty close to what is practised in Ghanaian polytechnics, which Effah (2005) described as unstructured. Fonselius, Hakala and Holm's (2001) discussion of students being responsible for looking for internship places themselves is comparable to the practice in Ghanaian polytechnics. While managed internships may be a better guarantee of a high quality internship experience, unmanaged internship may have the advantage that students have a better and more realistic perspective of the actual labour market, which is important for future employment (Divine et al., 2007). The drawback of the latter is that students who are not able to find a place themselves might not have an internship experience at all or might have a delay in their studies. In the case of managed internship practices, the educational institution has better control of the relevance and quality of the internship experiences of their students (League of Oregon Cities, 2009), which can ensure better coherence between the theory and practice learned in school and the experiences gained outside school (Walo, 2001).

Duration Internships can be organized in a full-time setting or concurrent with in-school learning in a part-time setting (Divine et al., 2007). Polytechnics in Ghana have adopted the former, which is similar to what is done by some Singaporean polytechnics (Republic Polytechnic, 2008). A 6-month mandatory period is earmarked for internship. This duration agrees with what is seen in other academic institutions around the globe (Lam & Xiao, 2000; Mihail, 2006; Walo, 2001). The full-time option has as its advantage the complete immersion of students in the world of work. It allows students to take internships in a wider geographical region and thus get acquainted with a larger variety of options. On the other hand, the part-time option allows for better exchange between various internship practices experienced by students and the theories they have learned in school.

Assessment Assessment of student internship practices assumes agreement between the expectations of the industry and the educational institutions about the tasks students can and should accomplish during their internships. However, several studies have shown that these expectations often differ (Lam & Ching, 2007; Waryszak, 2000), which may result in assessment practices in which the intern's supervisors from the educational institution and the industry differ (Republic Polytechnic, 2008; Walo, 2001).

It is expected that curriculum materials describing the joint expectations for student internships and the obligations for all involved may contribute to the implementation of effective internship practices. Involving core stakeholders in the design of such curriculum material is assumed to contribute to its quality and practicality.

Designing for Curriculum Quality

According to Kessels and Plomp (1999), the quality of educational programmes is, to a large extent, determined by the "consistency" of the curriculum. Kessels and Plomp (1999) distinguish between internal and external consistency. The logical sequence linking the various components of the curriculum is defined as internal consistency. Internal consistency is reached through a "systematic approach" (Kessels & Plomp, 1999). It implies the systematic design sequence of analysis, design, development, implementation and evaluation, comparable to the description of curriculum development by Van den Akker (2003).

External consistency, on the other hand, refers to the coherence of stakeholders' perceptions. External consistency is reached through a "relational approach", corresponding to the communicative paradigm (Kessels & Plomp, 1999). It implies the involvement of stakeholders in the design and development process, thereby revealing their perceptions of the main goals of the process and of how they should be achieved. Curriculum work is multifaceted; hence, the role or input of identifiable stakeholders in the design process should be given the utmost consideration. By so doing, their divergent needs may be catered for, thereby promoting the curriculum's relevance for its subsequent users.

Marsh and Willis (2003) identified several stakeholders in the entire process of planning and developing the curriculum. The stakeholders can range across educational officials, students, parents, members of the community and teachers. Within vocational education, the teacher, student and employer are usually seen as key stakeholders in the process of planning and developing the curriculum (Hughes, 2009). These stakeholders ensure that the collaboration between the educational institutions and industries is fostered, with the ultimate aim of enriching students with employable skills.

Teachers are the educational practitioners who live closest to the underlying tensions involved in curriculum work and who have the most at stake in understanding what curriculum development actually entails and how it influences them and the students (Marsh & Willis, 2003). Because teachers are core stakeholders in curriculum enactment, active involvement of teachers in curriculum design might essentially contribute to internal and external consistency. Research has shown that teachers' active involvement in the (re-)design of the curriculum results in curriculum materials that are both valid and feasible (Ben-Peretz, 1990; Clandinin & Connelly, 1992; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Recent studies have shown that the implementation of curriculum innovation is fostered when teachers collaboratively (re-) design the curriculum (Cviko, McKenny, & Voogt, 2014; Penuel et al., 2007; Simmie, 2007). We will refer to such practice as Collaborative Curriculum Design (CCD).

Designing curricula presupposes engagement in a number of activities that generally take the form of analysis, design and development, implementation, and evaluation. As Van den Akker (2003) stipulated, curriculum development is: *"…usually* *a long and cyclic process with many stakeholders and participants in which motives and needs for changing the curriculum are formulated; ideas are specified in programs and materials; and efforts are made to realize the intended changes in practice"* (p. 2). However, research on teachers' collaborative curriculum design has shown that the analysis phase is often underestimated or skipped when teachers collaboratively design curriculum (e.g., Handelzalts, 2009; Huizinga, 2014). For that reason, this study focuses on the first step of a collaborative curriculum design process, the context and needs analysis.

The Study

Research Purpose and Method

The context and needs study aimed at identification by the stakeholders of the problems regarding organisation of student internship in the polytechnics in Ghana and gave direction to subsequent design studies (Akomaning, 2012).

This study focused on the perceptions of key stakeholders in the Hotel Catering and Institutional Management (HCIM) sector in Ghana regarding problems and potential solutions in student internship. A cross-sectional survey study was conducted to solicit information from key stakeholders.

Data Collection

Four HCIM Departments were involved in the study. In total, 160 students, 40 alumni, 45 teachers, 12 management representatives and 20 representatives from the hospitality industry were selected as participants. A questionnaire was developed to gather information about the four components needed for effective internship practices (collaboration, placement, duration and assessment). The questionnaire contained mainly Likert-scale response items; in addition, a few open-ended questions were posed.

Teachers, students and management representatives were all sent questionnaires, and the response rates were 73%, 100% and 92% respectively. Alumni and hospitality industry representatives were also each sent a questionnaire. The response rate in each case was 100%.

Main Findings

The aim of this context and needs analysis was to identify problems and potential solutions in the organisation of student internship in the HCIM programmes in Ghana's polytechnics. The research question addressed stakeholders' perceptions of the organisation of student internship.

Perceptions of management representatives, teachers, students, alumni and industry personnel generally did not differ on the relevant conditions (collaboration, placement, duration and assessment) that contribute to the benefits derived from well-managed internship. The polytechnics' collaboration with industry needed to be reinvigorated to foster better management of student internship and creating enough capacity for students to having appropriate internships. Participants identified active involvement by industry and teachers in student internship and extension of time for internship as critical for interns' training.

Social, economic, and technical deficiencies and lack of professional commitment were challenges faced by students during their internship The major findings showed that students were assigned to one department for the entire training period in industry, jobs/duties assigned were manual and menial, supervision was lacking, workers had an uncooperative attitude towards interns, students were not able to fulfil the mandatory 3 month period of internship, 20% of students did not get an internship placement and the relationship between the polytechnics and industry was episodic.

The need for curriculum materials to guide student internship was expressed, because it was found that student internship had no written curriculum specifying the distinctive roles of teachers, students and industry personnel during the internship. To ensure quality of the curriculum materials in terms of consistency, practicality and effectiveness, all stakeholders need to have input into the design of curriculum materials for student internship.

Reflections

Capacity has been identified as one of the missing links in the organisation of student internship in Ghana's polytechnics. In the context of student internship, the application of capacity was unstructured and faced with challenges. Hence the expected mandated functions or roles of teachers, students and industry personnel were not being efficiently and effectively executed. In view of this, the research sought to address these challenges by adopting collaborative curriculum design as a bottom-up approach empowering teachers in the Departments of HCIM. Teachers in design teams, that work with the input provided from students and industry representatives, eventually designed curriculum materials to help streamline the activities of student internship.

The importance of taking into account the context within which needs are identified, which in this study was student internship in Departments of HCIM in polytechnics in Ghana, cannot be underestimated. The outcomes of the context and needs analysis study informed the industrial liaison officers, teachers, students and industry personnel (key stakeholders) in the hospitality management programme. Following this creation of awareness, the stakeholders, particularly the teachers, expressed the need for well-thought-out curriculum documents to be designed to help streamline the student internship. The need to design curriculum documents prompted the pursuit of collaborative curriculum design in design teams as a bottom-up approach that would be feasible for addressing the implementation challenges. The explicit input of various stakeholders through the needs and context analysis contributed to the development of external consistency during the process of curriculum design. In this research project, not only was teachers' active involvement necessary for the realization of valid and practical curriculum materials, but the involvement of industry and students was also key to the success of the curriculum materials.

References

Akomaning, E. (2012). *Improving student internship through collaborative curriculum design in Ghanaian polytechnics* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Akyeampong, K. (2010). *50 years of educational progress and challenge in Ghana*. Brighton, UK: University of Sussex: CREATE.

Alagaraja, M., & Arthur-Mensah, N. (2013). Exploring technical vocational education and training systems in emerging markets: A case study on Ghana. *European Journal of Training and Development, 37*(9), 835–850.

Bakar, M. J. A., Harun, R. J., Yusof, K., & Tahir, I. M. (2011). Business and accounting students' perceptions on industrial internship program. *Journal of Education and Vocational Research, 1*(3), 72–79.

Ben-Perez, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. Albany, NY: State University of New York Press.

Billett, S. (2001). Learning through work: Workplace affordances and individual engagement. *Journal of Workplace Learning, 13*(5), 209–214.

Billett, S. (2006). Constituting the workplace curriculum. *Journal of Curriculum Studies, 38*(1), 31–48.

Blokhuis, F. T. L., & Nijhof, W. J. (2008). Evidence-based design of workplace learning. In W. J. Nijhof & L. F. M. Nieuwenhuis (Eds.), *The learning potential of the workplace* (pp. 163–180). Rotterdam, The Netherlands: Sense Publishers.

Borkowski, S. (2008). *Internships for high school students. FastWeb, A Monster Company*. University of South Florida: A Program of Union Pacific Foundation.

Carlin, A., & Manson, D. (2007). My school, my teacher: A polytechnic approach to information assurance. *Communication of the IIMA, 7*(3), 65–78.

Christou, E. S. (1999). Hospitality management education in Greece: An exploratory study. *Tourism Management, 20*, 683–691.

Clandinin, D. J., & Connelly, F. M. (1992). Teacher as curriculum maker. In P. Jackson (Ed.), *Handbook of research in curriculum* (pp. 363–401). New York: Macmillan.

Clark, S. C. (2003). Enhancing the educational value of business internships. *Journal of Management Education, 27*(4), 472–484.

Collins, A. B. (2001). Gateway to the real world, industrial training: Dilemmas and problems. *Tourism Management, 23*, 93–96.

Cviko, A., McKenney, S., & Voogt, J. (2014). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers & Education, 72*, 68–79.

Divine, R., Linrud, J., Miller, R., & Wilson, J. H. (2007). Required internships in marketing: Benefits, challenges and determinants of fit. *Marketing Education Review, 17*(2), 45–52.

Effah, P. (Ed.). (2001). *Technical report series*. Accra, Ghana: Adwinsa Publications Ghana Ltd.

Effah, P. (2005). A decade of polytechnic education in Ghana: An assessment of achievements and failures. *Proceedings of the first Sunyani Polytechnic lecture series, 1*, 17–29.

Fonselius, J., Hakala, M. K., & Holm, K. (2001). *Evaluation of mechanical engineering education at Universities and Polytechnics* (*Publications of the Higher Education Evaluation Council 14:2001*). Helsinki, Finland: Edita.

Gervedink Nijhuis, C., Bakah, M. A. B., & Akomaning, E. (2009). Leadership challenges involved in managing institutional and curriculum changes in polytechnics. In W. Kouwenhoven, G. Oduro, & K. Nsiah-Gyabaah (Eds.), *Trends in polytechnic education in Ghana* (pp. 85–100). Amsterdam, The Netherlands: Vrije Universiteit.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Hughes, J. (2009). *The employability strategy June 2009*. Portsmouth, UK: University of Portsmouth.

Huizinga, T. (2014). *Developing curriculum design expertise through teacher design teams* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Japan International Cooperation Agency. (2001). *The study for the development of a master plan to strengthen technical education in the republic of Ghana. Final report*. Accra, Ghana: Ministry of Education.

Johnston, H. (2008). *Internships for high school students. The principal partnership: A program of Union Pacific Foundation.* Florida: University of South Florida.

Kessels, J., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709.

Lam, T., & Ching, L. (2007). An exploratory study of an internship program: The case of Hong Kong students. *Hospital Management, 26*, 336–351.

Lam, T., & Xiao, H. (2000). Challenges and constraints of hospitality and tourism education in China. *International Journal of Contemporary Hospitality Management, 12*(5), 291–295.

League of Oregon Cities. (2009). *Enrollment management and student affairs: Career center*. Portland, OR: Portland State University.

Levesque, K., Lauen, D., Teitelbaum, P., Alt, M., & Librera, S. (2000). U.S. Department of Education. National Center for Education Statistics. Vocational Education in the United States: Toward the Year 2000, NCES 2000-029, Washington, DC.

Marsh, C. J., & Willis, G. (2003). *Curriculum: Alternative approaches, ongoing issues* (3rd ed.). Upper Saddle River, NJ: Pearson Education.

Mihail, D. M. (2006). Internship at Greek Universities: An exploratory study. *Journal of Workplace Learning, 18*, 28–41.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Republic Polytechnic. (2008). *Placement services for employers*. Singapore, Singapore: Republic Polytechnic.

Schappert, M. (2005). *Employers' internship toolkit*. Syracuse, NY: Le Moyne College.

Simmie, G. M. (2007). Teacher design teams (TDTs) – Building capacity for innovation, learning and curriculum implementation in the continuing professional development of in career teachers. *Irish Educational Studies, 26*(2), 163–176.

Van den Akker, J. J. H. (2003). Curriculum perspectives: An introduction. In J. J. H. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Walo, M. (2001). Assessing the contribution of internship in developing Australian tourism and hospitality students' management competencies. *Asia-Pacific Journal of Cooperative Education, 2*(1), 21–28.

Waryszak, R. Z. (2000). Before, during and after: International perspective of students' perceptions of their cooperative education placements in the tourism industry. *Journal of Cooperative Education, 35*(2/3), 84–94.

Chapter 7
Identifying Needs for Support to Enhance Teachers' Curriculum Design Expertise

Tjark Huizinga, Nienke Nieveen, and Adam Handelzalts

Introduction

The design and implementation of curriculum reform are complex processes. However, various stakeholders repeatedly overlook this complexity. Consequently, despite the best intentions and ambitions, curriculum reforms are too often only partially implemented or fall short of realizing their educational goals (Fullan, 2007; Green, 1980; Stenhouse, 1975; Van den Akker, 2010). The failure of curriculum reform is often explained by the lack of involvement of the main stakeholder: the teacher (Fullan, 2007; Stenhouse, 1975). As Fullan stated it (1991, p. 117): 'Educational change depends on what teachers do and think – it is as simple and complex as that.' Borko (2004) also asserted that educational change is not likely to take place when teachers are merely viewed as practitioners who are expected to implement the plans of others. She implied that failure of curriculum reform is caused by teachers' lack of involvement and lack of ownership for the reform. Conversely, teachers' ownership of the curricular problem to be solved and their active involvement in the design process are often reported as the main mechanisms to foster the implementation of a curriculum reform. Various scholars have

T. Huizinga (✉)
Department of Innovative and Effective Education, Saxion University of Applied Sciences, Enschede, The Netherlands
e-mail: t.huizinga@saxion.nl

N. Nieveen
ELAN Department of Teacher Development, University of Twente, Enschede, The Netherlands
e-mail: n.m.nieveen@utwente.nl

A. Handelzalts
Teacher Education Department, Free University, Amsterdam, The Netherlands
e-mail: a.handelzalts@vu.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_7

indicated the need to involve teachers from the early stages of the curriculum reform process (e.g., Borko, 2004; Darling-Hammond & McLaughlin, 1995; Fullan, 2007; Stenhouse, 1975).

The importance and relevance of teachers' involvement in curriculum development becomes increasingly apparent when curriculum policy is considered. In the Netherlands, teachers formally and legally have a great deal of autonomy to shape and enact their own (school-specific) curriculum (Kuiper, Van den Akker, Hooghoff, & Letschert, 2006; Nieveen & Kuiper, 2012). Schools and teachers have been given 'curricular space' to shape and arrange their so-called school-based curricula (Nieveen, Van den Akker, & Resink, 2010). In terms of educational policy in The Netherlands, recent initiatives have underlined the importance of allowing teachers to become designers of curriculum materials that take the school's context and its students into account (e.g., Ministerie van Onderwijs, Cultuur en Wetenschap, 2011; Onderwijsraad, 2014; VO-Raad, 2014). Studies related to these initiatives have reported positive findings for teachers' collaboration in curriculum development. While designing, teachers can discuss the essence of the renewal and classroom implementation, which helps to improve teachers' understanding of the reform and fosters their ownership of the reform.

Although teachers in different contexts have been increasingly involved as designers in curriculum reform projects, not all efforts have been successful. The first attempts were ill-structured and teachers received little support during the process (e.g., Eggleston, 1980; Nieveen et al., 2010; Onderbouw-VO, 2009; Skilbeck, 1984). A major problem was that teachers lacked certain knowledge and skills needed to fulfil the proposed role of designer (Bakah, Voogt, & Pieters, 2012; Forbes, 2009; Handelzalts, 2009; Nieveen et al., 2010). For their efforts to succeed, it does not seem to be enough to rely on ownership, active involvement and willingness to cooperate in curriculum development. In order to play a significant role as curriculum designers and to successfully implement the new curriculum materials in their classrooms, teachers need to have specific knowledge and skills, in particular, subject matter knowledge, pedagogical content knowledge and curriculum design expertise (Nieveen et al., 2010; Nieveen & Van der Hoeven, 2011; Schwab, 1973). The various categories of expertise required for designing high quality curricula have been comprehensively defined as 'design expertise' (Hardré, 2003; Hardré, Ge, & Thomas, 2006; Huizinga, 2009; Huizinga, Nieveen, Handelzalts, & Voogt, 2013; Nieveen & Van der Hoeven, 2011). Design expertise consists of two components, namely *process and generic design expertise* and *specific design expertise*, which include teachers' expertise in curriculum design (Huizinga, 2009).

Although some teachers who fulfil the role of designer are expected to have intuitive design expertise, many of them lack this kind of expertise (Forbes, 2009; Handelzalts, 2009; Hardré et al., 2006; Kerr, 1981; Nieveen et al., 2010). Therefore, most teachers can be considered novices in curriculum design, and subsequently experience beginner's difficulties while designing curriculum materials (e.g., Ertmer & Cennamo, 1995; Kerr, 1981; Kirschner, Carr, Van Merriënboer, & Sloep, 2002). For teachers to end up with good quality materials and, ultimately, to play a decisive role in curriculum reform, it seems essential to support them in their collaborative design process, to help them tackle design challenges and to develop their design expertise (Handelzalts, 2009; Hardré et al., 2006; Nieveen, Handelzalts, Van den Akker, & Homminga, 2005).

The collaborative design of curriculum materials has been identified as a promising way to foster the design of high quality curriculum materials and to enhance classroom implementation (Handelzalts, 2009; Hardré et al., 2006; Fullan, 2007). Furthermore, teacher involvement in collaborative design processes offers opportunities to learn about the design process (Bakah et al., 2012; Voogt et al., 2011).

Recently, *professional learning communities* have become more popular as a means for teachers' professional development and have proven successful (Desimone, 2009, 2011; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Participation in these communities permits teachers to develop their expertise by sharing ideas and opinions and by reflecting on their practices (Hord, 2004; Little, 1990, 2003; Stoll et al., 2006). A concrete form of professional learning community aimed at curriculum development can be found in Teacher Design Teams [TDTs], which are teams of at least two teachers who collaboratively (re)design parts of their shared curriculum (Handelzalts, 2009). These teams can be considered design communities in which active learning by collaborative designing takes place. The activities and discussions in TDTs provide opportunities for developing the expertise needed to design and implement the new curriculum materials (Clarke & Hollingsworth, 2002; Coenders, 2010; Handelzalts, 2009). During TDT meetings, teachers discuss how a pedagogical approach is incorporated in the curriculum materials or exchange their experiences of using the materials in classroom practices. Furthermore, the members of TDTs can identify what actions are needed to further improve the designed curriculum materials. TDTs offer opportunities for teacher learning, especially when supported by an external facilitator and when support is related to teachers' subject matter knowledge, pedagogical content knowledge and curriculum design expertise (e.g., Desimone, 2009; Hoogveld, 2003; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Voogt et al., 2011).

Although working in TDTs has been advocated by various scholars (e.g., Bakah et al., 2012; Handelzalts, 2009; Penuel et al., 2007; Simmie, 2007; Voogt et al., 2011), little is actually known with regard to what design and implementation activities and what support offered by an external facilitator to TDTs provide opportunities to develop teachers' design expertise (Handelzalts, 2009; Hardré et al., 2006; Nieveen et al., 2010). In this study, this aspect will be explored in TDTs in schools where teachers work together on the design and implementation of a reformed curriculum.

Aim of the Study

This study focuses on the opportunities TDTs offer to teachers to develop their curriculum design expertise. The study was conducted in the context of a curriculum reform of a school subject. Teams of teachers from the same school intended to design curriculum materials (attuned to the curriculum reform) and implement these within their own classrooms. As discussed before, besides subject matter knowledge and pedagogical content knowledge, teachers also need curriculum design expertise in order to be able to design high quality curriculum materials. To identify what opportunities TDTs offer to develop teachers' curriculum design expertise, it is essential to get a better understanding of teachers' need for support and the actual support offered to TDTs. Identifying beneficial support and design activities may help improve the structure of future TDTs.

Conceptual Framework

In this section, the main concepts of the study are clarified. First, the overall concept of design expertise and specific design expertise of teachers as designers are introduced. Secondly, the opportunities and support that Teacher Design Teams provide to teachers to develop their design expertise are addressed.

In this study, teams of teachers (TDTs) within schools were faced with the implementation of a curriculum reform in their classrooms. These TDTs consisted of teachers from the same department, who collaboratively revised a school subject. The reform specifically required TDTs to align the school subject to an international framework developed for teaching and learning the subject according to a new approach (intended curriculum at supra level, beyond macro level). During their design process, teachers needed to develop a shared vision and common understanding of how this international framework affects their subject and their teaching (intended/implemented at meso level). Based on this shared vision the teacher teams were to develop lesson materials that could be used in the classrooms (intended/implemented curriculum at micro level). The curriculum materials at this stage included lesson materials for students and assessment rubrics.

Design Expertise

It is generally agreed upon that teachers taking up the role of designer need specific knowledge and skills to plan and carry out design processes (Bakah et al., 2012; Forbes, 2009; Hardré, 2003; Huizinga, 2009; Richey, Field, & Foxon, 2001). Although various scholars (e.g., Eggleston, 1980; Marsh, Day, Hannay, & McCutcheon, 1990) have pointed out the importance of such knowledge and skills, the conceptualization and operationalization of the required knowledge and skills covered by this concept differ. To identify the relevant knowledge and skills for teachers as designers, insights from prior studies in which teachers fulfilled the role of designers (e.g., Forbes, 2009; Handelzalts, 2009) and overviews of the task of professional instructional designers (e.g., Richey et al., 2001; Seels & Glasgow, 1991) were combined.

An overview of expertise as defined for professional designers (Richey et al., 2001) and the expertise teachers need in order to fulfil the role of curriculum designer (e.g., Forbes, 2009; Hardré, 2003; Hardré et al., 2006), including design activities performed by teachers as curriculum designers (e.g., Richey et al., 2001), consists of pedagogical design capacity, instructional design competencies, and design expertise. Teachers' attitudes, although in practice essential for successful curriculum design, were not addressed in this study. Problems teachers encounter during curriculum design processes mainly relate to a lack of teachers' knowledge and skills (e.g., Handelzalts, 2009; Kerr, 1981). Therefore, the definition by Hardré et al. (2006) was taken as a starting point and was adapted to fit to the context of teachers who fulfil the role of designer. This led to the following definition of design expertise: 'the knowledge and skills required to design high quality curriculum materials'.

In a prior study, Huizinga (2009) identified the knowledge and skills that teacher designers need to develop high quality curriculum materials. Based on a literature review and expert validation, he concluded that design expertise consists of *generic design and process expertise* and *specific design expertise*. The *generic design and process expertise* addresses the knowledge and skills required for any type of design process (e.g., collaboration and project management skills). The *specific design expertise* addresses the knowledge and skills specifically required for developing curricula (e.g., subject matter knowledge and curriculum design expertise).

In the current study, the emphasis is on teachers' specific design expertise. Teachers as designers need this expertise to cope with design challenges that they might face during the design process. In this study, the categories 'curriculum design expertise' and 'curriculum consistency expertise' were combined in the concept of curriculum design expertise, because it appeared that these categories overlapped. Curriculum consistency expertise is teachers' ability to design materials that are internally and externally consistent (Kessels & Plomp, 1999; Van den Akker, 2003). Whereas internal consistency reflects the logic contingencies of the components of the curriculum, external consistency refers to a shared understanding of the content and nature of the curriculum that needs to be designed In the next section, teachers' specific design expertise will be elaborated in depth.

Specific Design Expertise

Specific design expertise reflects teachers' knowledge and skills for curriculum design. As indicated before, since teachers can generally be identified as novices in curriculum design, it seems essential to develop their specific design expertise. Teachers' subject matter knowledge and their pedagogical content knowledge were identified to be beneficial for fulfilling the role of designer (e.g., Coenders, 2010; Huizinga, 2009; Schwab, 1973). These will be elaborated first, followed by an elaboration of the additional knowledge and skills teachers as designers need in order to conduct curriculum design processes (curriculum design expertise).

Subject Matter Knowledge

The design of high quality materials implies that the designed materials are relevant, consistent, practical and effective (e.g., Nieveen, 2009; Nieveen & Folmer, 2013). Subject matter knowledge, which is represented in the curriculum materials, needs to be accurate, relevant and up-to-date. It is expected that throughout their professional career, teachers apply various strategies to keep their knowledge up-to-date, for example, by collegial consultation, reading literature and attending conferences (e.g., Brandes & Seixas, 1998; Davis & Krajcik, 2005; Kessels, 2001). They use their subject matter knowledge when creating the curriculum materials. Teachers need to be able to attune subject matter knowledge to suit the students and the difficulties students have with the subject matter (Angeli & Valanides, 2009; Kreber & Cranton, 2000; Marks, 1990; Richey, Klein, & Nelson, 2004).

Pedagogical Content Knowledge

The designed curriculum materials not only need to represent accurate and up-to-date subject matter knowledge, but they also need to fit a specific pedagogical approach. The pedagogical approach depends on the rationale (or vision) of the curriculum reform (as indicated in the spiderweb of Van den Akker, 2003) and is expected to be reflected in the strategies and corresponding instructional and learning activities, in the materials and resources, in the assessment strategies, and so on. Teachers' expertise for selecting, designing and applying strategies and corresponding activities for teaching and learning specific goals and content has been defined as pedagogical content knowledge [PCK] (Shulman, 1986). Teachers need to have a deep understanding of the subjects they teach, the various possible pedagogical approaches and which instructional activities are relevant and effective for their students (Marks, 1990; Shulman, 1986). PCK is an important prerequisite for developing curriculum materials, because teachers' understanding of the pedagogy is reflected in the curriculum materials they select, adapt and/or develop (Forbes, 2009; Koehler & Mishra, 2008; Koehler, Mishra, & Yayha, 2007; Remillard, 2005). Therefore, during curriculum reform, teachers' PCK usually needs to be further developed before teachers start designing curriculum materials.

Curriculum Design Expertise

The concept of curriculum design expertise is grounded in the phases distinguished in curriculum and instructional design models (e.g., Hardré et al., 2006; Huizinga, 2009; Richey et al., 2001; Seels & Glasgow, 1991). For each stage of the design model, teachers as designers are expected to have specific knowledge and skills that help them to successfully navigate the design process and to tackle the challenges they face while designing. Huizinga (2009) identified six aspects of curriculum design expertise that teachers need during curriculum design processes: Systematic curriculum design skills, curriculum decision-making skills, problem statement skills, idea generation skills, implementation management skills, and formative and summative evaluation skills.

Applying a systematic and iterative design approach is beneficial for the quality of the designed curriculum materials (Dick, Carey, & Carey, 1985; Gustafson, 2002). Taking a *systematic curriculum design* approach prevents vital design activities from being neglected during the design process. A systematic design approach is not necessarily linear, but consists of various iterations of design activities (Gustafson & Branch, 2002; Visscher-Voerman, 1999). When teachers carry out design processes, they usually concentrate on the design of learning activities and curriculum materials (Forbes, 2009; Handelzalts, 2009; Kerr, 1981). Because of contextual limitations and teachers' limited curriculum design expertise, they often skip important design activities (Bakah et al., 2012; Handelzalts, 2009; Kerr, 1981), in particular, analysis and evaluation activities, which then affects the quality of the designed materials. Consequently, teachers might develop curriculum materials that do not suit the learners or do not reflect the reform (Handelzalts, 2009). To prevent the curriculum materials from being of poor quality, teachers need to be aware of the importance of analysis, design, development, implementation and evaluation activities and the influence of these activities on the internal and external consistency of the curriculum materials (Kessels & Plomp, 1999).

During all design activities, *decisions need to be made* that affect the curriculum materials and the design process (Dick et al., 1985; Gustafson & Branch, 2002). Justifying the decisions made and using insights from various sources are expected to result in well-considered curriculum materials. Teachers as designers use their practical understanding of the classroom, teaching and their students to support their design decisions (Forbes, 2009; Handelzalts, 2009). They rarely use insights from (scientific) literature during the design process to improve the quality of the materials or to guide their design process (Handelzalts, 2009). Insights from the literature are usually offered by external facilitators who help to guide the overall design process and offer support (e.g., Linder, 2011; Nieveen et al., 2005). To prevent teachers' misconceptions from affecting the curriculum materials, teachers need to be informed about relevant and useful scientific and practical insights during the design process.

A shared vision of the aim of the design process and its expected outcomes is vital for guiding the design process (Handelzalts, 2009; Hord, 2004). A shared *problem statement must be formulated* as a result of conducting various analysis activities. Moreover, the key concepts of the reform need to be clarified, since they guide the design process and are used to determine if the design process has been successful (Handelzalts, 2009; Hord, 2004). Previous studies have indicated that teachers rarely conduct analysis activities to identify students' needs and characteristics and the contextual boundaries of the reform in their particular context (Beyer & Davis, 2009; Forbes, 2009; Handelzalts, 2009). Moreover, at the start of the design process, teachers as designers tend to skip the development of a shared vision and understanding (e.g., Coenders, 2010; Handelzalts, 2009). Given the importance of a shared vision, which guides the remainder of the design process, teachers need to improve their understanding of conducting analysis activities and developing a shared vision.

An important step in tackling the identified problem is to *identify possible solutions* (Richey et al., 2001), for instance, by using brainstorming techniques (e.g., Christensen & Osguthorpe, 2004). Prior studies in which teachers fulfilled the role of designer demonstrated that teachers often start designing by generating various ideas about the curriculum materials (Coenders, 2010). Teachers' understanding of the existing materials, of previous efforts to tackle (similar) problems and of the curriculum reform help teachers to generate ideas and to determine what materials need to be developed. While generating ideas, teachers compare their ideas to one another, and the best ideas are put into material form and used for developing the curriculum materials (Handelzalts, 2009; Kerr, 1981).

Classroom *implementation* of the designed materials is a key element of the design process (Fullan, 2007; Richey et al., 2001), because this is how the reform is enacted in classroom practice. Prior studies have demonstrated that the implementation of the new curriculum materials is not self-evident. Teachers as designers need to discuss the teacher role, teacher-student interaction and other practical concerns with colleagues outside the TDT (Handelzalts, 2009; Penuel et al., 2007). Handelzalts (2009) argued that this rarely happens, which affects classroom implementation. To prevent other relevant stakeholders (e.g., school's management and colleagues outside the TDT) from lacking ownership of the designed curriculum materials, teachers as designers need to understand the importance of shareholder involvement and be able to involve stakeholders in the design process.

To assess the quality and merit of the designed curriculum materials, designers need to *conduct formative and summative evaluations* (Nieveen, 2009; Scriven, 1991). Formative evaluations help to improve the quality of the designed curriculum materials, because the outcomes of the evaluations are used to further improve the materials before they are implemented in classroom practice. Summative evaluations often emphasise student learning and help to determine whether the materials are beneficial for students. These outcomes are also used to improve or redesign the curriculum materials. Previous studies have shown that teachers do not plan and structure evaluations (Handelzalts, 2009; Kerr, 1981), which can be the result of having little understanding of how to assess the quality of curriculum materials (Handelzalts, 2009; Nieveen et al., 2005). To prevent implementation of materials that do not suit the context, do not foster student learning and do not represent the reform, teachers need to improve their understanding of conducting structured evaluations.

Developing Curriculum Design Expertise Through TDTs

For the success of curriculum reform, it seems essential to assist teachers in developing their curriculum design expertise (e.g., Beyer & Davis, 2009, 2012; Handelzalts, 2009; Hardré et al., 2006; Hoogveld, 2003; Kerr, 1981; Nieveen et al., 2010). This can happen via various ways of capacity building (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Desimone (2011), summarizing research on teachers' professional development, distinguished a number of effective components of professional development, two of which are especially relevant for developing teachers' curriculum design expertise: *Active learning* (opportunities to develop knowledge through activities such as observing, receiving feedback or presenting progress to others) and *collaborative participation* (participating together with fellow teachers from the same grade, subject, or school in a learning community). Participation in a design community, such as a TDT, in which active learning takes place by collaboratively designing curriculum materials, meets these conditions (Coenders, 2010; Handelzalts, 2009; Simmie, 2007; Voogt et al., 2011). Therefore, working in professional learning communities or teacher communities provides opportunities to share and develop new expertise (Pareja Roblin, Ormel, McKenney, Voogt, & Pieters, 2014), and is assumed to be beneficial for teachers to develop their curriculum design expertise, for instance, by discussing the design and implementation of the curriculum reform in classroom practice. These discussions help teachers to better understand the reform and to better conduct curriculum design (Voogt et al., 2011). In addition to designing, teachers are expected to use the curriculum materials in their classroom practices. Classroom implementation offers a prime opportunity to experience the reform and to reflect on its enactment in practice (Anto, 2013; Clarke & Hollingsworth, 2002; Lieberman & Pointer Mace, 2008). Teacher involvement in collaborative curriculum design offers opportunities for teachers to develop their curriculum design expertise, especially when support is offered to the teachers while designing (Penuel et al., 2007; Voogt et al., 2011).

Ideally, support offered to TDTs is attuned to teachers' existing expertise, their experience in curriculum design, the challenges they encounter in the design process and the expected outcomes of the design process (Desimone, 2011; Garet, Porter, Desimone, Birman, & Yoon, 2001; Loucks-Horsley et al., 1998). Teachers' individual existing expertise and experiences might differ within the team, which makes support for the development of curriculum design expertise a complex process (Hardré et al., 2006).

Previous studies have indicated the importance of an external facilitator to support TDTs (e.g., Linder, 2011; Nieveen et al., 2005; Patton, Parker, & Neutzling, 2012; Velthuis, 2014; Voogt et al., 2011). External facilitators can offer new insights about the design process and the reform, help the TDT to conduct design-related activities and help to foster reflection activities. The external facilitator can apply two styles of support (Linder, 2011; Nieveen et al., 2005). First, facilitators can apply proactive support. This facilitation style requires that facilitators help to structure the design process *before* design activities are conducted. The support is predesigned and aligned with the articulated need for support. Second, facilitators can offer reactive support. This support is aligned to the progress of the design team and is expected to be offered just-in-time, since new insights are offered when teachers face design challenges. Finally, combining the two styles can also be identified as a way to facilitate teachers' professional development (Linder, 2011).

Support to Enhance Teachers' Design Expertise

Support of teachers during curriculum design aims to update teachers' subject matter knowledge, teachers' (technological) pedagogical content knowledge, their curriculum design expertise and their understanding of the particular reform (Bakah et al., 2012, Nieveen et al., 2005; Stenhouse, 1975). However, how to support teachers is less clear, or as Nieveen et al. (2005, p. 22) indicated, 'there is no single best way in the innovation process'. This raises a dilemma for facilitators on how to support the development of design expertise in TDTs. However, aligning teachers' and facilitators' preferences for support is vital, since it prevents a difference in expectations about the role of the facilitators (Nieveen et al., 2005). This role depends on the aim of the support, team size and contextual limitations (Garet et al., 2001; Hardré et al., 2006; Loucks-Horsley et al., 1998).

Two strategies for supporting TDTs can be distinguished. First, support that is part of the team's design process is offered just-in time and is context specific. This strategy provides opportunities to offer meaningful support to TDTs (Loucks-Horsley et al., 1998), since teachers can determine the relevance and usefulness of the support offered for their design process (Desimone, 2009). Second, support can be offered in the form of specific workshops or training sessions to foster teachers' subject matter knowledge, pedagogical content knowledge and/or curriculum design expertise (Bakah et al., 2012; Garet et al., 2001; Hardré et al., 2006; Nieveen et al., 2005). In this scenario, workshops and training sessions are offered with specific predefined aims or learning goals. Since such support is offered in various contexts and is evaluated, the quality and effectiveness of the support are determined and improved before it is offered to new TDTs (Loucks-Horsley et al., 1998). However, the effect of this approach has been questioned, because teachers cannot directly apply the newly acquired knowledge and skills in practice. Therefore, Lumpe (2007) recommends organizing workshops and specific training sessions as an integral part of just-in-time support.

Facilitators play a crucial role in the support offered to design teams. Facilitators can offer proactive and reactive support (Nieveen et al., 2005). When offering proactive support, facilitators help steer the team during the design process (e.g., outlining the process) and make sure that teachers do not skip important design activities (e.g., conducting evaluations). In contrast, when offering reactive support, facilitators follow the team's enacted design process, react to the decisions made and make sure that all important design activities are enacted. During both reactive and proactive support, facilitators determine the support based on the teams' articulated needs for support. Given the varying expectations of the support and preferences of teachers within teams, balancing proactive and reactive support seems essential for the design process (Nieveen et al., 2005).

Research Question

The study was undertaken to identify opportunities TDTs provide to develop teachers' curriculum design expertise, in the context of TDTs within schools that redesigned a school subject. The opportunities that are provided by teacher involvement in TDTs are expected to be the result of the TDT's design activities and the support activities offered by external facilitators.

In this chapter we will report on the analysis that aimed at identifying the needs for support, guided by the research question: *What are TDTs' needs for support during collaborative design of a lesson series?*

Method

Procedure and Participants

A qualitative cross-sectional approach was used to reconstruct the design process as experienced by six teachers and six facilitators. The respondents were selected using a purposeful sampling technique (Patton, 1987). Each respondent was interviewed using a semi-structured interview guide that was adapted from Huizinga's study (2009). The interview addressed the design process, the design problems that occurred, how teachers and facilitators overcame these problems and what support was offered. Transcriptions and summaries were made and used during data analysis. The data were coded using an iterative coding process in which deductive coding was applied first, followed by inductive coding.

A two-stage process was applied to select the teachers. First, schools were selected that offered interdisciplinary courses. Second, within the selected schools, teachers who had experience with designing course materials for these interdisciplinary courses in teams were approached. Teachers had from 4 to 25 years of teaching experience and 2–8 years of design expertise.

A similar two-stage process was applied to select the facilitators. First, six organizations that offer support to TDTs were selected to participate in this study. Second, one facilitator within each organization was selected based on experience with supporting TDTs that had designed interdisciplinary courses. Facilitators had from 1.5 to 13 years of facilitator experience. The selected facilitators did not offer support to the selected teachers but were involved in similar projects, in order to get a broader picture of the need for support.

Instruments

Semi-structured interview guides for teachers and facilitators were developed based on the theoretical framework and the aim of the study. The interview guides were adapted from Huizinga's (2009) study to address the enacted design process and the support offered. Both interview guides were discussed with an expert in the field of TDTs. In each interview, teachers and facilitators were asked to reflect on the enacted design process. Follow-up questions were posed to gain additional insights into the projects' characteristics (e.g., aim of the project, subjects involved, etc.). Once the key characteristics of the project were clear, the respondents were asked to give a brief overview of problems that occurred and, if applicable, how they overcame the problems related to teachers' curriculum design expertise. Finally, the support activities offered and the extent to which they met teachers' needs were discussed.

Data Analysis

For all interviews, a transcription and a written summary were made. The summaries were based on parts of the transcriptions and were sent to the respondents for member checking (Merriam, 1988). These data sources were then analysed using an iterative coding process. In the first step, all summaries were coded using a predefined codebook. For each theme in the interview guides, codes were created based on the extended theoretical framework. The codes referred to the design expertise-related problems the TDTs experience, as discussed above.

Inductive coding was applied in order to identify the support activities offered to tackle the problems experienced and those activities offered to address teachers' needs. In addition, inductive coding was applied to retrieve additional insights regarding problems that occurred during the design process and were not identified ahead of time.

Investigator triangulation was achieved by determining the inter-coder reliability. A research assistant was involved in checking the reliability of the coding done by the first author of this chapter. One summary and one transcription were initially coded by the research assistant and differences in code interpretation were discussed with the first author until consensus was achieved. Then, 3 out of 12 interviews were re-coded independently by the research assistant, which led to an acceptable inter-rater reliability (Krippendorff's Alpha) of 0.72.

Main Findings

This study explored gaps in teachers' design expertise required for designing a lesson series. These insights can be used to develop and offer support during such design processes. Prior research has already indicated that teachers require support to tackle design-related problems during design processes (e.g., Ben-Peretz, 1990;

Nieveen et al., 2005; Stenhouse, 1975). However, little was known about the specific kind of support needed to enhance teachers' design expertise. In this study, teachers and facilitators reflected on a school-specific collaborative design process in which they experienced and tackled several problems related to specific design expertise. Based on the results, three gaps in teachers' design expertise were identified, namely:

1. Curriculum design expertise
2. Pedagogical content knowledge
3. Curricular consistency expertise

Each of these gaps will be discussed in terms of the problems experienced and support offered to overcome the problems.

Curriculum Design Expertise

During their design process, the teachers developed and implemented the lesson series in practice. However, they experienced several problems during the process. A major problem according to both teachers and facilitators related to defining the problem statement. Teachers encountered ill-defined shared visions of their future practice at the start of their design process, which affected the design activities (cf. Handelzalts, 2009), especially when teachers *within* the same TDT had different expectations. Subsequently, teachers designed materials that did not suit the newly developed practice.

Facilitators also recognised TDTs' problems with creating the problem statement. Therefore, they offered TDTs support for developing the teams' shared vision about their future practice. This support helped teachers to clarify what they wanted to achieve in the design process.

Scholars in the field of instructional and curriculum design have strongly articulated the importance of enacting a systematic design processes and enacting evaluation activities (Hardré et al., 2006; Richey et al., 2001; Seels & Glasgow 1991), since this is beneficial for the quality of the designed product (Gustafson, 2002). However, teachers rarely design according to existing design models (e.g., Hoogveld, 2003; Handelzalts, 2009; Kerr, 1981). The results of this study confirm this. We found that teachers rarely performed analysis activities, such as a learner or context analysis. In contrast to Handelzalts (2009, p. 208), who argued that teachers *'are not inclined to initiate evaluation activities of any sort'*, the teachers in this study did enact several evaluations of the designed lesson series, since they were insecure about the quality of the designed materials. However, facilitators and teachers both reported that teachers did not know *how* to enact evaluation activities and *how* to determine the quality of the materials created (cf. Handelzalts, 2009; Kerr, 1981).

The support offered by facilitators to enhance teachers' systematic curriculum design skills mainly focused on the design and evaluation activities, probably because facilitators were not involved in the initial stages of the design process. While supporting the design and evaluation stages, facilitators reflected with the team on their shared vision and the expected outcomes. This support also consisted of enacting some activities to clarify the vision. During the design stage, support addressed how teachers could design digital materials and offered just-in-time support during the (co-)construction of curricular frameworks and templates. The templates helped teachers to structure the design activities and to focus on the content of the lesson series instead of on the materials' layout. Similar support was offered for conducting evaluation activities, since facilitators provided checklists or feedback, or taught teachers *how* to enact evaluations.

In order to increase teachers' curriculum design expertise, it seems essential that TDTs receive support during *all* stages of the design process (Hoogveld, 2003; Nieveen et al., 2005). Based on the results of this exploratory study, it seems especially essential to support TDTs during the analysis and evaluation stages, since they experience the most knowledge and skills-related problems while enacting these activities.

Pedagogical Content Knowledge

Both teachers and facilitators in this study indicated that TDTs had, in general, sufficient pedagogical content knowledge to design the lesson series. However, some teachers argued that they experienced some minor problems with selecting an appropriate pedagogy to suit the interdisciplinary character of the course. Also, facilitators argued that teachers required new insights into what is involved in offering interdisciplinary courses (cf. Krajcik, McNeill, & Reiser, 2007).

Facilitators offered some insights into applying new pedagogy in practice, for example, by offering a workshop to let teachers and students experience a new approach. Given the insights from professional development programs (e.g., Garet et al., 2001; Van Driel, Meirink, Van Veen, & Zwart, 2012), which indicate that collaborative learning and the connection to teachers' classroom practice are essential, the pedagogy-related support that was offered seems beneficial for increasing teachers' pedagogical repertoire. In addition, Handelzalts (2009) noted that helping teachers to visualise their future practice by piloting, conducting school visits and discussing blueprints can also be offered to enhance teachers' understanding of new pedagogy.

Teachers' ability to choose materials that suit the selected pedagogy has been identified as a part of teachers' pedagogical content knowledge for designing (e.g., Huizinga, 2009; Nieveen & Van der Hoeven, 2011). During the design of a lesson series, teachers select and often adapt the materials found to their own context (Remillard, 2005). Teachers in this study criticised the materials found in digital repositories on their practical usability and did not use the materials. Instead, they used the repositories to get inspiration. One reason might be that teachers lack the technical skills to make the required adaptations to the digital materials (cf. Wilhelm & Wilde 2005).

Facilitators discussed with teachers how they could search for existing materials and when to select them. One facilitator indicated that his organization also offered background information about the search process for a specific repository. Similar support was provided to experienced teachers as designers in the study by Strijker and Corbalan (2011). Their study illustrated that this support improved the search process and that the materials that were found suited their context.

Finally, the teachers who designed digital materials experienced difficulties related to pedagogy and integration of ICT, especially when they had limited ICT skills for designing teaching materials. The integration of ICT required teachers to be familiar with ICT and able to make adjustments in order to fit it into the teaching materials (cf. Agyei, 2012; Alayyar, 2011).

In order to increase teachers' pedagogical content knowledge for designing, it seems fruitful to gain insights about teachers' pedagogical content knowledge in relation to the expected outcomes (e.g., do they have experience with the new pedagogy). Based on this exploratory study, it seems helpful to offer some technical support for teachers to make contextual adaptation to digital materials found in repositories. This prevents the loss of valuable time in (re)creating materials that are already available.

Curriculum Consistency Expertise

Teachers also experienced difficulties in creating curriculum materials that were internally and externally consistent (cf. Handelzalts, 2009; Van den Akker 2003). The support offered to create an internally consistent lesson series was already partly discussed in the previous sections (e.g., templates and helping with conducting evaluations). Teachers felt insecure about the materials' quality, which they partly tackled by using templates. Yang, Fox, Wildemuth, Pomerantz, and Oh (2006) also argued that templates are useful to prepare high-quality curriculum materials. For the design of a lesson series, they also articulated the need for curricular frameworks to organise the individual materials in a well-considered order. Yet facilitators rarely offered such frameworks, despite indications by Yang et al. (2006) that it might be beneficial to offer them to teachers.

External consistency, on the other hand, was affected by different understandings within TDTs about the key concepts of the reform. Moreover, teachers within TDTs also had different expectations about the lesson series they were designing. A shared vision is required to foster the design and implementation of the lesson series, but it takes some time to develop (Handelzalts, 2009; Hord, 2004).

Handelzalts (2009) provided guidelines for teachers and facilitators to foster the development of the team's shared vision. He suggested that activities should be initialised to help teachers to create concrete images of their future practice. This study showed that such activities included visualizing the team's ideas by using Venn diagrams, posing reflective questions about the team's intentions and expected outcomes and discussing with the team how they wanted to achieve these outcomes. Facilitators used this input to align the vision of the individual teachers.

Reflections

Teachers as Designers

Although teachers are used to adapting existing materials to fit their context and learners (Forbes, 2009; Remillard, 1999, 2005; Cviko, Mckenney, & Voogt, 2013), designing curriculum materials that encompass a curriculum reform at the subject level is a more complex design task that is often new to them. This study showed that teachers were able to fulfil the role of designer regarding this complex task under the condition that they could collaborate in a TDT and received sufficient support (cf. Handelzalts, 2009). This study also showed that in order to develop teachers' curriculum design expertise, teachers need to be actively involved in conducting design activities (cf. Lohuis, Huizinga, 't Mannetje, & Gellevij, 2016). However, in contrast to what was found in the study by Cviko et al. (2013), where teachers in TDTs adopted the designer role to design a series of lesson activities in the context of ICT use to foster early literacy education in kindergarten, this study showed that when teachers are involved in more complex design task they need additional support. This support, in particular, needs to help them (more than was seen in this study) in planning and performing analysis and evaluation activities, because these activities are not undertaken by TDTs as such. As the study by Lohuis et al. (2016) illustrated, providing teachers with support by using a stepwise design approach and offering just-in-time support from educational designers and ICT designers helps teachers to develop their design expertise.

By taking up the role of designer, teachers developed not only their curriculum design expertise, but also their pedagogical content knowledge (PCK). In this study, teachers needed to develop their PCK to get a deep understanding of the reform framework and how to integrate the curriculum materials they were to design within the reform framework. Although the (few) exemplary curriculum materials assisted teachers in developing an understanding of the design task and improved their understanding of the curriculum reform, teachers needed their (existing) PCK to come up with ideas for the curriculum materials that had to be developed.

Curriculum Design Expertise

In this study, the concept of curriculum design expertise was used to identify the knowledge and skills teachers as designers need to have in order to conduct curriculum design activities (cf. Huizinga, 2009; Nieveen & Van der Hoeven, 2011). Together with teachers' subject matter knowledge and pedagogical content knowledge, curriculum design expertise is part of teachers' specific design expertise. The findings of this study revealed convincing evidence about teachers' curriculum design expertise and which aspects of curriculum design expertise teachers need to further develop.

Curriculum design expertise has been conceptualised as the ability to adopt a systematic and iterative approach to curriculum design. The underlying rationale for this conceptualization is that this approach helps prevent the neglect of important design activities during the design process (Gustafson, 2002; Gustafson & Branch, 2002). The assumption of this study was that when teachers have a comprehensive understanding of the curriculum design process, they can better plan and operationalise the design activities. Furthermore, they can monitor whether all design activities have been conducted, and are able to identify if important design activities have been ignored. Teachers can still integrate a more pragmatic or prototypical approach to curriculum design within this systematic and iterative approach, since understanding curriculum design as a systematic and iterative approach does not imply a strictly linear approach that prescribes *when* to conduct *which* design activities. The results of this study showed that teachers have an incomplete conceptual understanding of curriculum design processes, resulting in TDTs skipping important and relevant design activities. To develop a comprehensive understanding of curriculum design as a systematic and iterative approach, TDTs need additional external support.

Developing Curriculum Design Expertise

Working in TDTs

During the overall study, teams of teachers worked together on the design and implementation of a curricular reform. As this specific study also showed, working in TDTs offered opportunities for teacher learning about the reform and about curriculum design (cf. Penuel et al. 2007; Voogt et al., 2011). To improve teachers' understanding of curriculum design, the identified need for support indicates that teachers need to reflect on the design activities they conduct and to share their reflections with colleagues (cf. Hall & Hord, 2010). As the findings of the overall study demonstrated, explication of the design process and the intentions of the designed materials with colleagues, both within as well as outside the TDT, are powerful means for improving teachers' understanding of and expertise in curriculum design (cf. Hall & Hord, 2010; Hardré et al., 2006; Voogt et al., 2011). Therefore, TDTs need to conduct these kinds of explication and reflection activities during the design process. Facilitators of TDTs can help teachers to initiate such reflection activities and sharing experiences with fellow-teachers.

External Support

Supporting TDTs during their effort to collaboratively design and implement curriculum materials is vital (cf. Becuwe, Tondeur, Pareja Roblin, Thys, & Castelein, 2016; Handelzalts, 2009; Nieveen et al., 2005; Patton et al., 2012; Voogt et al., 2011). Support not only fosters the design process, but also offers additional opportunities for teacher learning about curriculum design, the pedagogy, the subject matter and the overall reform ideas. The findings of this study underline that teachers as designers require specific support to foster the design process. The need for support includes developing teachers' curriculum design expertise and PCK. This study showed that teachers need support throughout the whole design process, and in particular for conducting analysis and evaluation activities (cf. Handelzalts, 2009; Kerr, 1981). By offering such support, the quality of the designed curriculum can be improved (cf. Nieveen & Folmer, 2013; Scriven, 1991). This kind of support can be offered by external facilitators, but also in the form of tools and templates that help teachers conduct concrete design activities (such as templates for selecting materials and tools to conduct a formative evaluation of the materials with students).

Oftentimes support to TDTs is offered by an external facilitator, which was also the case in this study. When an external facilitator is involved, the style of support offered needs to be attuned with the TDT and their expectations (cf. Odenthal, 2003). In general, two facilitating styles can be offered to TDTs, namely, a proactive and a reactive support style. Both support styles are aligned to teachers' need for support, either based on teachers' articulated need for support at the start of the design process (proactive) or teachers' need for support during the design process (reactive). In the overall study, the proactive support style aimed at improving teachers' conceptual understanding of curriculum design by attuning the support meetings to the stages of the ADDIE-model (Analysis, Design, Development, Implementation, Evaluation; Gustafson & Branch, 2002). The reactive support style in the overall study had a just-in-time nature and was attuned to the progress of the TDT. As the results of this study indicated, teachers tend to prefer a reactive, just-in-time, support style, since it is aligned to their progress in the design process. Still, it can result in teachers skipping important design activities. Therefore, a combination of both design styles seems essential. As the studies by Linder (2011), Lohuis et al. (2016) and Patton et al. (2012) showed, it is essential to offer support that is attuned to the progress of the TDTs' design process and to help teachers to structure the design activities. In order to achieve this, recent studies have also acknowledged the variety of roles that facilitators fulfil while supporting teacher teams, ranging from a coordinator role to supporting the community-building within the team (e.g., Margalef & Pareja Roblin, 2016).

In addition to the support style, the number of support meetings and the design phase in which the support is offered also influence the opportunities for teacher learning and the quality of the designed materials. Facilitators in this study were mainly involved during the design and development phases of the design process. This resulted in minimal support during implementation and evaluation activities. The articulated need for support suggests that teachers require support during *all* phases of the design process to help them understand the importance of conducting analysis and evaluation activities. In the study by Lohuis et al. (2016), support was offered to TDTs for conducting formative evaluations by offering support from an educational designer and by providing a checklist that helped teachers to identify to what extent the designed curriculum materials were aligned with the reform.

Curriculum Design Expertise of Facilitators

Given the importance of support offered by an external facilitator, it is essential that the facilitators themselves have a deep understanding of curriculum design. Facilitators need to be able to plan and conduct analysis, design, evaluation and implementation activities and provide teachers with relevant insights into how to conduct these activities in the school context. They also need to be able to identify the stage of the ADDIE model with which the design activities are related. The facilitators in this study varied in their facilitating style as a result of the different phases they were involved in during the design process and their personal preferences for offering support. Their own curriculum design expertise might also have affected the support style they offered.

Facilitators need to know which design processes fit the context in which TDTs will work. Therefore, a facilitator is expected to identify which design approach is most applicable and relevant for the TDT, given the aim of the design process and the contextual boundaries.

References

Agyei, D. D. (2012). *Preparation of pre-service teachers in Ghana to integrate information and communication technology in teaching mathematics*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Alayyar, G. M. (2011). *Developing pre-service teacher competencies for ICT integration through design teams*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*, 154–168.

Anto, A. G., (2013). *Collaborative teacher professional development in Ethiopian higher education: The case of communicative language teaching*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012). Advancing perspectives of sustainability and large-scale implementation of design teams in Ghana's polytechnics: Issues and opportunities. *International Journal of Educational Development, 32*, 787–796.

Becuwe, H., Tondeur, J., Pareja Roblin, N., Thys, J., & Castelein, E. (2016). Teacher design teams as a strategy for professional development: The role of the facilitator. *Educational Research and Evaluation, 22*(3–4), 141–154.

Ben-Peretz, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. Albany, NY: State University of New York Press.

Beyer, C., & Davis, E. A. (2009). Using educative curriculum materials to support preservice elementary teachers' curricular planning: A comparison between two different forms of support. *Curriculum Inquiry, 39*(5), 679–703.

Beyer, C., & Davis, E. A. (2012). Learning to critique and adapt curriculum materials: Examining the development of preservice elementary teachers' pedagogical content knowledge. *Science Education, 96*(1), 130–157.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15.

Brandes, G. M., & Seixas, P. (1998). Subjects and disciplines: Asymmetries in a collaborative curriculum development project. *Teachers and Teaching: Theory and Practice, 4*(1), 95–114.

Christensen, T. K., & Osguthorpe, R. T. (2004). How do instructional-design practitioners make instructional-strategy decisions? *Performance Improvement Quarterly, 17*(3), 45–65.
Clarke, D. J., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*(8), 947–967.
Coenders, F. (2010). *Teachers' professional growth during the development and class enactment of context-based chemistry student learning material*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.
Cviko, A., McKenney, S. E., & Voogt, J. M. (2013). The teacher as re-designer of a technology integrated curriculum for emergent literacy. *Journal of Educational Computing Research, 48*(4), 447–468.
Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan, 76*(8), 597–604.
Davis, E. A., & Krajcik, J. S. (2005). Designing educative curriculum materials to promote teacher learning. *Educational Researcher, 34*(3), 3–14.
Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher, 38*(3), 181–199.
Desimone, L. M. (2011). A primer on effective professional development. *Phi Delta Kappan, 96*(6), 68–71.
Dick, W., Carey, L., & Carey, J. O. (1985). *The systematic design of instruction*. Boston: Allyn & Bacon.
Eggleston, J. (1980). *School-based curriculum development in Britain: A collection of case studies*. London: Routledge & Kegan Paul.
Ertmer, P. A., & Cennamo, K. S. (1995). Teaching instructional design: An apprenticeship model. *Performance Improvement Quarterly, 8*(4), 43–58.
Forbes, C. T. (2009). *Preservice elementary teachers' development of pedagogical design capacity for inquiry: An activity-theoretical perspective*. Doctoral dissertation, University of Michigan, Ann Arbor, MI.
Fullan, M. G. (1991). *The new meaning of educational change* (2nd ed.). London: Casell Educational Limited.
Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.
Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.
Green, E. L. (1980). The independent learning in science model of school-based curriculum development. In J. Eggleston (Ed.), *School-based curriculum development in Britain: A collection of case studies* (pp. 14–40). London: Routledge & Kegan Paul.
Gustafson, K. L. (2002). Instructional design tools: A critique and projections for the future. *Educational Technology Research and Development, 50*(4), 59–66.
Hall, G. E., & Hord, S. M. (2010). *Implementing change: Patterns, principles, and potholes* (3rd ed.). New York: Pearson College Division.
Gustafson, K. L., & Branch, R. M. (2002). *Survey of instructional development models* (4th ed.). Syracuse, NY: Syracuse University.
Handelzalts, A. (2009). *Collaborative curriculum design in teacher design teams*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.
Hardré, P. L. (2003). The effects of instructional training on university teaching assistants. *Performance Improvement Quarterly, 16*(4), 23–39.
Hardré, P. L., Ge, X., & Thomas, M. K. (2006). An investigation of development toward instructional design expertise. *Performance Improvement Quarterly, 19*(4), 63–90.
Hoogveld, A. W. M. (2003). *The teacher as designer of competency-based education*. Doctoral dissertation, Open University, Heerlen, The Netherlands.
Hord, S. M. (2004). *Learning together, leading together: Changing schools through professional learning communities*. New York: Teachers College Press.

Huizinga, T. (2009). *Op weg naar een instrument voor het eten van docentcompetenties voor het ontwikkelen van curricula* [Towards an instrument to measure teachers' competencies for the development of curricula; Master's thesis]. University of Twente, Enschede, The Netherlands.
Huizinga, T., Nieveen, N., Handelzalts, A., & Voogt, J. M. (2013). Ondersteuning op curriculumontwikkelexpertise van docentontwikkelteams [Support to teacher design teams to foster teachers' curriculum design expertise]. *Pedagogische Studiën, 90*(3), 4–20.
Kerr, S. T. (1981). How teachers design their materials: Implications for instructional design. *Instructional Science, 10*, 363–378.
Kessels, J. W. M. (2001). Learning in organisations: A corporate curriculum for the knowledge economy. *Futures, 33*(6), 497–506.
Kessels, J. W. M., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709.
Kirschner, P., Carr, C., Van Merriënboer, J. J. G., & Sloep, P. (2002). How expert designers design. *Performance Improvement Quarterly, 15*(4), 86–104.
Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. In AACTE Committee on Innovation and Technology (Ed.), *The handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3–29). Mahwah, NJ: Lawrence Erlbaum Associates.
Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*, 740–762.
Krajcik, J. S., McNeill, K. L., & Reiser, B. J. (2007). Learning-goal-driven design model: Developing curriculum materials that align with national standards and incorporate project-based pedagogy. *Science Education, 92*(1), 1–32.
Kreber, C., & Cranton, P. A. (2000). Exploring the scholarship of teaching. *Journal of Higher Education, 71*(4), 476–495.
Kuiper, W., Van den Akker, J., Hooghoff, H., & Letschert, J. (2006). Curriculum policy and school practice in a European comparative perspective. In J. Letschert (Ed.), *Curriculum development re-invented*. Proceedings of the invitational conference on the occasion of the 30 years SLO 1975-2005. Leiden, the Netherlands, 7–9 December 2005 (pp. 56–77). Enschede, The Netherlands: SLO.
Lieberman, A., & Pointer Mace, D. (2008). Teacher learning: The key to education reform. *Journal of Teacher Education, 59*(3), 226–234.
Linder, S. M. (2011). The facilitator's role in elementary mathematics professional development. *Mathematics Teacher Education and Development, 13*(2), 44–66.
Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.
Little, J. W. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record, 105*(6), 913–945.
Lohuis, A. H., Huizinga, T., 't Mannetje, J. E. M. M., & Gellevij, M. R. M. (2016). *Improving support to Teacher Design Teams to foster teachers' design expertise and blended learning expertise*. Paper presented during the EAPRIL conference, Porto, Portugal.
Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. (1998). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.
Lumpe, A. T. (2007). Research-based professional development: Teachers engaged in professional learning communities. *Journal of Science Teacher Education, 18*(1), 125–128.
Margalef, L., & Pareja Roblin, N. (2016). Unpacking the roles of the facilitator in higher education professional learning communities. *Educational Research and Evaluation, 22*(3–4), 155–172.
Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education, 41*(3), 3–11.
Marsh, C., Day, C., Hannay, L., & McCutcheon, G. (1990). *Reconceptualizing school-based curriculum development*. New York: The Falmer Press.
Merriam, S. B. (1988). *Case study research in education*. San Francisco: Jossey-Bass.

Ministerie van onderwijs, cultuur en wetenschap. (2011). *Leraar 2020 – een krachtig beroep! [Teacher 2020 - a powerful profession]. Den Haag: Minsterie van Onderwijs, Cultuur en Wetenschap*. Available online at: http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2011/05/23/actieplan-leraar-2020.html. Accessed 8 Aug 2014

Nieveen, N. (2009). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 89–102). Enschede, The Netherlands: SLO.

Nieveen, N., & Folmer, E. (2013). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *Educational design research Part A: An introduction* (pp. 152–169). Enschede, The Netherlands: SLO.

Nieveen, N., Handelzalts, A., Van den Akker, J. J. H., & Homminga, S. (2005). *Teacher design teams: A scenario for school-based curriculum innovation*. Paper presented at the ECER, Dublin, Ireland.

Nieveen, N., & Kuiper, W. (2012). Balancing curriculum freedom and regulation in the Netherlands. *European Educational Research Journal, 11*(3), 357–368.

Nieveen, N., Van den Akker, J. J. H., & Resink, F. (2010). Framing and supporting school-based curriculum development in the Netherlands. In E. H. Law & N. Nieveen (Eds.), *Schools as curriculum agencies: Asian and European perspectives on school-based curriculum development* (pp. 273–283). Rotterdam, The Netherlands: Sense Publishers.

Nieveen, N., & Van der Hoeven, M. (2011). Building the curricular capacity of teachers: Insights from the Netherlands. In P. Picard & L. Ria (Eds.), *Beginning teachers: A challenge for educational systems – CIDREE yearbook 2011* (pp. 49–64). Lyon, France: ENS de Lyon, Institut français de l'Éducation.

Odenthal, L. E. (2003). *Op zoek naar balans. Een onderzoek naar een methode ter ondersteuning van curriculum vernieuwing door docenten* [Searching for balance: Researching methods for supporting curriculum renewal by teachers; Doctoral dissertation]. University of Twente, Enschede, The Netherlands.

Onderbouw-VO. (2009). *Blijvend in beweging. Vier jaar onderbouwontwikkeling. Monitor 2005–2008 [Staying in motion. Four years of development: Yearly evaluations 2005–2008]*. Zwolle, The Netherlands: Onderbouw-VO.

Onderwijsraad. (2014). *Een eigentijds curriculum [A contemporary curriculum]*. Den Haag, The Netherlands: Onderwijsraad.

Pareja Roblin, N., Ormel, B., McKenney, S., Voogt, J. M., & Pieters, J. M. (2014). Linking research and practice through teacher communities: A place where formal and practical knowledge meet? *European Journal of Teacher Education, 37*(2), 183–203.

Patton, K., Parker, M., & Neutzling, M. M. (2012). Tennis shoes required: The role of the facilitator in professional development. *Research Quarterly for Exercise and Sport, 83*(4), 522–532.

Patton, M. Q. (1987). *How to use qualitative methods in evaluation* (2nd ed.). London: Sage.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry, 29*, 315–342.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211–246.

Richey, R. C., Fields, D. C., & Foxon, M. (2001). *Instructional design competences: The standards* (3rd ed.). Syracuse, NY: Clearinghouse on Information & Technology Syracuse University.

Richey, R. C., Klein, J. D., & Nelson, W. A. (2004). Developmental research: Studies of instructional design and development. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (2nd ed., pp. 1099–1130). Bloomington, IN: Association for Educational Communications & Technology.

Schwab, J. J. (1973). The practical 3: Translation into curriculum. *School Review, 81*(4), 501–522.

Scriven, M. (1991). *Evaluation thesaurus* (4th ed.). Newbury Park, CA: Sage.

Seels, B., & Glasgow, Z. (1991). *Survey of instructional design needs and competencies*. Paper presented at the Annual Convention of the Association for Educational Communication and Technology, Orlando, FL.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.
Simmie, G. M. (2007). Teacher design teams (TDTs) – Building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies, 26*(2), 163–176.
Skilbeck, M. (1984). *School-based curriculum development*. London: Harper & Row.
Stenhouse, L. (1975). *An introduction to curriculum research and development*. London: Heinemann Educational Books.
Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*, 221–258.
Strijker, A., & Corbalan, G. (2011). *Zoeken en arrangeren met leerlijnen [Searching and arranging with curricular frameworks]*. Enschede, The Netherlands: SLO.
Van den Akker, J. J. H. (2003). Curriculum perspectives: An introduction. In J. J. H. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.
Van den Akker, J. J. H. (2010). Building bridges: How research may improve curriculum policies and classroom practices. In S. Stoney (Ed.), *Beyond Lisbon 2010: Perspectives from research and development for education policy in Europe* (CIDREE Yearbook 2010) (pp. 175–195). Slough, UK: NFER.
Van Driel, J. H., Meirink, J. A., Van Veen, K., & Zwart, R. C. (2012). Current trends and missing links in studies on teacher professional development in science education: A review of design features and quality of research. *Studies in Science Education, 48*(2), 129–160.
Velthuis, C. (2014). *Collaborative curriculum design to increase science teaching self-efficacy*. Doctoral dissertation, University of Twente, Enschede, The Netherlands.
Visscher-voerman, J. I. A. (1999). *Design approaches in training and education: A reconstructive study.* Doctoral dissertation, University of Twente, Enschede, The Netherlands.
VO-Raad. (2014). *Klaar voor de toekomst! Samen werken aan onderwijskwaliteit. Sector akkoord VO 2014–2017 [ready for the future! Collaborating on the quality of education. Sectoral agreement secondary education 2014–2017]*. VO-Raad: Den Haag.
Voogt, J. M., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S. E., Pieters, J. M., et al. (2011). Teacher learning in collaborative curriculum design. *Teacher and Teaching Education, 27*(8), 1235–1244.
Wilhelm, P., & Wilde, R. (2005). Developing a university course for online delivery based on learning objects: From ideals to compromises. *Open Learning, 20*(1), 65–81.
Yang, S., Fox, E. A., Wildemuth, B. M., Pomerantz, J., & Oh, S. (2006). Interdisciplinary curriculum development for digital library education. *Digital Libraries: Achievements, Challenges and Opportunities, 4312*, 61–70.

Chapter 8
Developing TPACK in Science and Mathematics Teacher Education in Tanzania: A Proof of Concept Study

Ayoub Kafyulilo and Petra Fisser

The Development of ICT in Education in Tanzania

To ensure the effective training of teachers for integration of technology in their teaching, in 2009 the government of Tanzania introduced the Information and Communication Technology for Teacher Professional Development (ICT-TPD) framework (United Republic of Tanzania [URT], 2009). The ICT-TPD framework is being implemented through the ICT for Science, Mathematics and English (ICT-SME) project and the Bridge IT project, in secondary and primary education respectively. The ICT-SME project was initiated in 2010 and is being implemented under the consultancy of the *Global e-Schools and Communities Initiative* (GESCI). In this project, tutors from selected teacher training colleges are trained to integrate technology in teaching and learning, after which they teach the practicing teachers in selected secondary schools all over the country (Hooker, Mwiyeria, & Verma, 2011). Tutors in the ICT-SME project are provided with laptops and data projectors to facilitate the training of practicing teachers (Hooker et al., 2011). Additionally, the Bridge IT project was initiated in 2011 to introduce ICT into the teaching and learning of science, mathematics and vocational skills in primary education. The Bridge IT project is being implemented in 17 districts in seven regions of Tanzania, where over 150 primary schools are benefiting from it. The project utilizes a large number of ICT tools including radios, videos and TV broadcasts to enhance teaching and learning in the subjects mentioned (URT, 2011).

A. Kafyulilo (✉)
Department of Psychology and Curriculum Studies, Dar es Salaam University College of Education, Dar es Salaam, Tanzania
e-mail: vangidunda@yahoo.co.uk

P. Fisser
National Institute for Curriculum Development, Enschede, The Netherlands
e-mail: p.fisser@slo.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_8

A country-wide survey on the status of ICT integration in education showed that in Tanzania ICT use is more prevalent in urban private secondary schools than public schools (Swarts & Wachira, 2010). According to Swarts and Wachira, computer use in schools was limited to teaching of basic ICT skills and no integration into the teaching and learning process was observed. Moreover, a study by Mwalongo (2011) on pre-service and in-service teachers' ICT uses in teaching and learning revealed that the majority of teachers were using computers for preparing notes, teaching and learning resources, preparation of school announcements, reports, letters, students' registration and preparation of examinations. Mwalongo added that almost all surveyed schools had computers and television (TV) sets, and teachers also had mobile phones with cameras, but they did not use the computers and the digital cameras from their mobile phones for academic purposes; in some schools, the available computers were not used at all. According to Swarts and Wachira (2010), some of the factors hindering the use of technology in teaching are: inadequate training and capacity, resulting in underutilization of ICT facilities; a widespread view of ICT as a status symbol rather than a tool; and lack of awareness of the multifaceted range of ICT and how these technologies can be used to address the existing challenges of teaching and learning. Others were lack of common understanding and awareness among stakeholders about the benefits that ICT can bring to education, and lack of skilled manpower to implement technology-enhanced curriculum.[1]

The findings by Hare (2007), Mwalongo (2011), Senzige and Serukesi (2004), Swarts and Wachira (2010), and Vesisenaho (2007) revealed that ICT use in teaching in Tanzania was limited. Across all of these studies, it was acknowledged that technological tools (computers and TVs) were available in almost all secondary schools with electricity connection in urban areas. Although at least two teachers from each school were trained on the use of ICT in teaching, and the ICT tools were somehow available in some schools, the uptake of technology nonetheless remained limited and confined to administrative and personal uses (Swarts & Wachira, 2010). The problems identified by Hare (2007), Mwalongo (2011), and Swarts and Wachira (2010) call for a professional development arrangement to develop teachers' knowledge and skills for integrating technology in teaching,[2] which they currently are lacking. Therefore, a professional development arrangement to develop teachers' technology integration knowledge and skills was designed and implemented for science and mathematics subjects. Science and mathematics subjects have the highest failure rates in schools in Tanzania, and technology is being adopted as an important tool for enhancing teaching and learning in these subjects. The initial stage of the research was a proof of concept study, in which a professional development arrange-

[1] In this chapter, the term "technology-enhanced" is used to describe a lesson or curriculum that is supported by technology; e.g., technology-enhanced science and mathematics lessons.

[2] In this chapter, the term "technology integration" is used to describe the knowledge and skills for using technology in teaching; e.g., technology integration knowledge and skills for science and mathematics teaching.

ment that incorporates 'learning technology by design' was conducted with pre-service teachers. This chapter reports on that study.

Theoretical Underpinnings

In this section, the theoretical underpinnings on which this study was based are presented. First, the potential of technology use for science and mathematics teaching and learning is described, followed by an elaboration of Technological Pedagogical Content Knowledge (TPACK) as a conceptual framework for describing the knowledge teachers need to effectively integrate technology into science and mathematics teaching. After that, the theoretical considerations underpinning collaborative design in teams, the support provided during lesson design in teams and lesson implementation are outlined.

Technology in Science and Mathematics Education

Schools and governments all over the world are introducing technology into education, both as itself a discipline (subject) and as an instructional tool in the other disciplines (Plomp, Anderson, Law, & Quale, 2009). With technology as a discipline, schools and governments have been working towards preparing a generation of people who can use technology such as computers and other sophisticated digital tools in their day-to-day life. As an instructional tool, technology use is being implemented in schools as an important tool for enhancing teaching and learning. According to Webb (2008), the obvious benefit of using technology such as computer simulations in science teaching is to enable the exploration of phenomena that are too difficult or dangerous to investigate experimentally, phenomena that are too small or too large to be seen, and those that happen too fast or too slow for direct observation. Simulations of processes that cannot easily be observed such as meiosis or mitosis in biology permit students to visualise and investigate these phenomena (Webb, 2008). Studies by Keong, Horani, and Daniel (2005) and Niess et al. (2009) reported the value of technology in supporting learner-centered teaching approaches, in which learners use technology to explore and reach an understanding of scientific and mathematical concepts by concentrating on problem-solving processes rather than on calculations related to the problems. Likewise, Özgün-Koca, Meagher, and Edwards (2010) argued that technologies including graphing and some computer-based mathematics learning programs can enhance young students' conceptual and procedural knowledge of mathematics. Keong et al. (2005) reported that the use of technology in teaching science and mathematics improves students' learning by increasing collaboration among students and enhancing the level of communication and sharing of knowledge.

Studies on technology integration in science and mathematics teaching show that teachers' instructional practices are enhanced when they use technology to teach (Jimoyiannis, 2010). According to Özgün-Koca et al. (2010), "as teachers decide whether and how to use technology in their teaching, they need to consider the science or mathematics content that they will teach, the technology that they will use, and the pedagogical methods that they will employ" (p. 11). Teachers also need to reflect on the critical relationships between science or mathematics concepts, the technology they use, and the pedagogy that can support learning. Based on Ozgun-Koca et al. (2010), the question of what teachers need to know and how they should learn it in order to appropriately integrate technology in their science and mathematics teaching is the most important one to address, and it is the primary focus of this chapter.

Niess et al. (2009), citing the National Council of Teachers of Mathematics (2007), asserted that if teachers are to learn how to create a positive environment that promotes collaborative problem-solving, incorporates technology in a meaningful way, invites intellectual exploration, and supports student thinking, they themselves must experience learning in such an environment. Niess and colleagues called for teacher training colleges to train teachers in the same way they would like the graduating teachers to use to teach with technology in schools. There is an overarching conception that teachers' beliefs about how to teach science and mathematics are aligned with how they learned science and mathematics (Niess et al., 2009). Niess and colleagues further argued that teachers who learn to solve science and mathematics problems through the use of graphing calculators, spreadsheets and educational software can better embrace the use of those tools in teaching science and mathematics. Similarly, Richardson (2009) recommended that in order for technology to become a tool for learning mathematics, mathematics teachers must develop an understanding of their subject matter and what it means to teach it using technology. In connection with this, Ferrini-Mundy and Breaux (2008) argued that "in the absence of professional development on instructional technology and curriculum materials that integrates technology use into the lesson content, teachers are not particularly likely to embed technology-based or technology-rich activities into their courses" (p. 437).

Therefore, teachers need to know not only the science and mathematics subjects they teach, but also the manner in which the subject matter can be changed by technology applications (Jimoyiannis, 2010). Teachers need to develop knowledge of various technologies as they are used in teaching and learning settings, and conversely, to know how science and mathematics teaching might change as the result of using particular technologies (Richardson, 2009). According to Niess et al. (2009), the development of such knowledge requires a model that captures the progression of science and mathematics instruction, as teachers integrate technology into their teaching and learning (cf. Jimoyiannis, 2010; Wentworth, Graham, & Tripp, 2008). The need for a model was also addressed by Koehler and Mishra (2009), who argued that at the heart of good teaching there are three components; content, pedagogy and technology, plus the relationships between and among them. This means teachers need to develop not only knowledge of technology, pedagogy and content, but also the knowledge of how these knowledge domains are related. This knowledge requirement for teachers was described by Koehler and Mishra (2005, 2009) in a conceptual framework called Technological Pedagogical Content Knowledge (TPACK). In this study, TPACK is used as a framework for describing the knowledge teachers need to integrate technology in their science and mathematics teaching and as a guide for the design of professional development arrangements to develop technology integration knowledge and skills among pre-service and in-service science and mathematics teachers.

Technological Pedagogical Content Knowledge (TPACK)

TPACK is built on Shulman's (1986) Pedagogical Content Knowledge (PCK), and is intended to capture how teachers' understanding of educational technologies and PCK interact with one another to produce effective teaching with technology. Although Shulman's notion of PCK included the use of technologies in teaching, Mishra and Koehler (2008) argued that because of the immersed role of technology in our society and the rapid changes in technology, there is the need to add technology knowledge (TK) as a third knowledge domain. Technological knowledge is knowledge about the various educational technologies, ranging from low-grade technology such as pencil and paper to digital technology such as the internet, digital video, interactive whiteboard, and so forth (Koehler & Mishra, 2009). While Koehler and Mishra (2009) describe technology as including both analogue and digital technologies, in this study the concept of technological knowledge refers specifically to knowledge of digital technologies. This encompasses, for example, knowing how to operate a computer and knowing how to use a multitude of technological tools (e.g., digital camera, data projectors, etc.) and software tools (PowerPoint, word processors, spreadsheet, e-mail, animations, video, internet, etc.) as well as knowing how to troubleshoot in problematic situations (cf. Voogt, Fisser, Pareja Roblin, Tondeur, & Van Braak, 2013).

Koehler and Mishra (2005) viewed teacher knowledge about technology as important, but not as separated from and unrelated to contexts of teaching; that is, such knowledge is not only about what technology can do, but also, and perhaps more importantly, about what technology can do for them as teachers. They proposed a framework describing teachers' understanding of the complex interplay between technology, content, and pedagogy, or Technological Pedagogical Content Knowledge (TPCK). TPCK occurs as a result of the integration of three components; Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK). The interactions between these components lead to the formation of Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPCK) (Fig. 8.1). Moreover, the circle encompassing all of the components together represents a context. Teachers are supposed to develop the ability to flexibly navigate the spaces defined by the three elements;

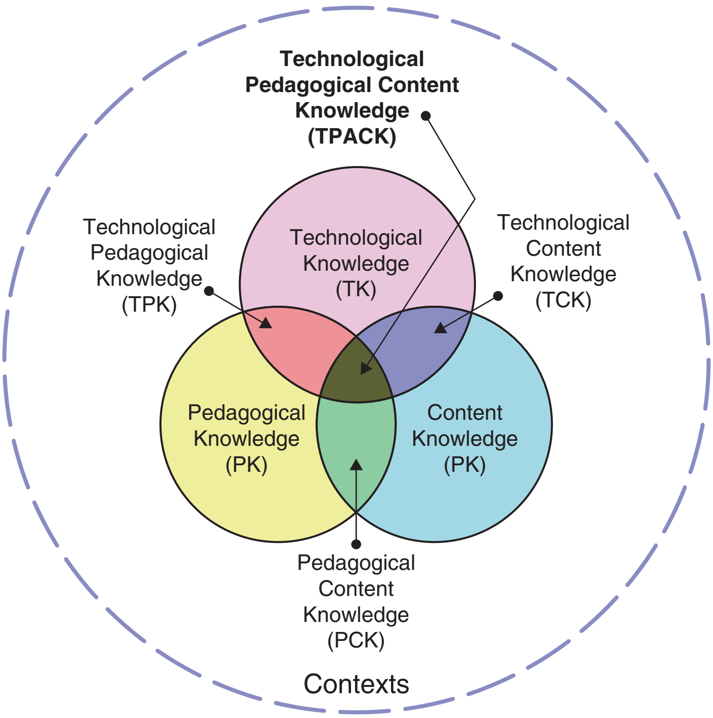


Fig. 8.1 TPACK framework. (Koehler & Mishra, 2009)

content, pedagogy, and technology and the complex interactions among these elements in specific contexts (Koehler & Mishra, 2009). Mishra and Koehler (2006) described TPCK as:

> the basis of good teaching with technology which requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (p. 1029).

TPCK is typically written with an "A" to make it TPACK. According to Thompson and Mishra (2007–2008), the "A" was added to the framework to simplify its pronunciation, as well as to represent the Total PACKage of the components within the framework. Thompson and Mishra (2007–2008) argued that the acronym TPCK is somewhat problematic and difficult to say, and even getting the letters in the correct order is a challenge for most people.

Koehler et al. (2011) argued that most existing technologies are not designed for educational purposes. Making specific technology applications into an instructional tool requires creative input, as well as knowledge and skills from the teacher in order to re-design the technology, the pedagogy and the content. Koehler, Mishra, and Yahya (2007) presented learning technology by design as a promising approach for developing teachers' knowledge and skills for integrating technology into their teaching. According to Koehler et al. (2007), in learning technology by design, teachers work collaboratively in small groups to develop technology-rich solutions to authentic pedagogical problems; in this way, they learn about technology and pedagogy by actually using and designing educational technology to teach specific content. Koehler et al. (2011) described learning technology by design as an effective instructional technique for developing a deeper understanding of the relationships between technology, pedagogy and content. They further argued that design-based learning involves working collaboratively on solving authentic problems rather than learning through lectures and demonstrations. Alayyar, Fisser and Voogt (2011) adopted learning technology by design in a professional development arrangement to develop pre-service teachers' technology integration knowledge and skills in science teaching. In their study, pre-service teachers worked in design teams of three to four to design technology-enhanced science lessons. A study by Agyei and Voogt (2012) similarly used learning technology by design, having pre-service teachers work in groups of two to design technology-enhanced mathematics lessons and subsequently teach those lessons to peers through microteaching. According to Agyei and Voogt (2012) and Alayyar et al. (2011), teachers' collaborative design in teams offers effective learning experiences for developing the knowledge and skills needed to integrate technology in their teaching.

Collaborative Design in Teams

According to Borko, Jacobs, Eiteljorg and Pittman (2008), professional development programs that allow teachers to share, grow professionally and reflect on their practices through inquiry-based interaction can enhance teachers' effectiveness in science teaching. Borko et al. (2008) called for well-designed professional development programs to provide teachers with opportunities to share ideas, opinions, and challenges, to reflect on their technology integration practices and to grow professionally (cf. Guzey & Roehrig, 2009). Teachers' collaboration in teams seems to be an effective professional development technique for providing these conditions (Handelzalts, 2009; Simmie, 2007). Handelzalts (2009) described collaborative design in teams as teacher design teams, and defined these as "a group of at least two teachers from the same or related subjects, working together on a regular basis, with the goal to (re)design and enact (a part of) their common curriculum" (Handelzalts, 2009, p. 7). This study adopted collaborative design in teams as part of a professional development arrangement for developing pre- and in-service teachers' knowledge and skills for integrating technology into their science and mathematics teaching. Teachers' collaborative design in teams has been reported to provide teachers with a creative space to reconsider the teaching of their subjects, the intellectual stimulus of working together and the challenge to move their thinking forward (Simmie, 2007). Thus, it was expected that the development of teachers' technology integration knowledge and skills introduced through collaborative design in teams could have a long-term impact on teachers' use of technology in science and mathematics teaching.

Koehler et al. (2011) claimed that through engaging in pedagogical design with technology around specific content areas, teachers not only gain knowledge of content, pedagogy and technology, but also engage in dialogue and collaboration to develop and scaffold their learning. Through collaborative design in teams, preservice and in-service teachers can engage in deep conversations about their practices; they are provided with opportunities to experiment and play with ideas, tools and subject matter; and they are offered with contexts to reflect on their learning. Voogt et al. (2011) argued that collaborative design in teams that aims to improve students learning should not only focus on collaborative curriculum (lesson) design, but also on curriculum (lesson) implementation as an integral part of design in teams. In their study, Voogt et al. (2011) found that active involvement in collaborative curriculum (lesson) design helped teachers to change their knowledge, skills and beliefs about good teaching and being a good teacher. In addition, during classroom implementation, teachers were able to show how they changed their classroom practices using the knowledge they had developed during the design activities. According to Riveros, Newton, and Burgess (2012), improvement initiatives for teachers, need to engage the teachers in deeper reflection about the nature of actions and practices in schools, specifically those practices that pertain to professional learning. As part of the collaborative design in teams used in this study, two additional aspects of teachers' learning to integrate technology in science and mathematics teaching were incorporated in the professional development arrangement: support options and the Interconnected Model of Professional Growth (IMPG) (Clarke & Hollingsworth, 2002).

The Support

In order to enable teachers to collaborate effectively and learn from their practices, collaborative lesson design, lesson implementation in the classroom and reflection, several support options were provided to teachers in this study. The support options were: collaboration guidelines, an expert, exemplary lessons and online learning materials such as animations, videos and pictures. When working with technology, teachers are subjected to technological and pedagogical challenges related to technology use and integration in the teaching and learning process. In order to address these challenges, scaffolding from a facilitator or an expert is required. As observed in the work by Voogt, Tilya and Van den Akker (2009), modifying traditional teaching techniques to incorporate technology is not easy; it requires teachers to broaden their teaching repertoire. A study by Allan, Erickson, Brookhouse and Johnson (2010) revealed that provision of scaffolded tasks to teachers and the opportunity to collaborate with experts and peers enhances teachers' learning. Moreover, the use of online learning materials such as animations, simulations and videos can save time for teachers in designing technology-enhanced lessons.

Exemplary lessons are another important support for teachers' learning about technology integration in science and mathematics teaching. Exemplary lessons help teachers get a clear picture of the goal of their learning, provide them with the necessary background information and support them while they practice what they have learned in their own classroom (Van den Akker, 1988). According to Voogt (2010), exemplary lessons can offer concrete lessons for use by teachers to provide them with practical experience or can serve as a model for teachers to create their own lesson plans. Above all, working in design teams is always challenging to teachers in terms of arriving at agreement and planning how to spend time (Bakah, 2011). To ensure effective use of time and better design output, teachers require guidelines to provide a sense of direction for their collaboration in design teams. Thus, teachers were provided with the collaboration guidelines to guide them in their discussion and decision-making in the design teams. According to Handelzalts (2009), collaboration guidelines have potential for guiding teachers' interactions in design team meetings.

Research Question

In this study, a professional development arrangement was designed and implemented to develop pre-service and in-service science and mathematics teachers' technology integration knowledge and skills. The study had two important innovations for teachers in Tanzania: collaborative design in teams (offered as a professional development arrangement) for developing technology integration knowledge and skills, and TPACK, which was adopted as a framework for describing the pre-service and in-service teachers' knowledge requirements for integrating technology into their science and mathematics teaching. This chapter provides a general view of the pre-service teachers' perceived and observed knowledge and skills for integrating technology in teaching science and mathematics. It also presents the pre-service teachers' perceptions of the effectiveness of each of the components of the professional development arrangement they attended.

The main research question was: "*What is the impact of pre-service and in-service teachers' participation in the collaborative design of technology-enhanced lessons in order to develop the knowledge and skills for integrating technology into their science and mathematics teaching?*"

Method

This study adopted a design research approach. Plomp (2009) defined design research as:

> the systematic study of designing, developing and evaluating educational interventions (such as programs, teaching-learning strategies and materials, products and systems) as solutions for complex problems in educational practice, which also aims at advancing our knowledge about the characteristics of these interventions and the processes of designing and developing them. (p. 13).

McKenney and Reeves (2012) characterized design research by its commitment to developing theoretical insights and practical solutions simultaneously, in real-world contexts, and together with stakeholders. They further argued that design research is concerned with the development of usable knowledge, which is constructed during the research and shared with other researchers and practitioners (cf. Wang & Hannafin, 2005). Moreover, design research is iterative and flexible (Reeves, 2006). This was also indicated by Wang and Hannafin (2005), who described design research as a systematic but flexible methodology aimed at improving educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and use of contextually-sensitive design principles and theories.

Reeves (2006) described four important phases in design research: problem analysis, solution development and iterative refinement in evaluation cycles, and reflection on the design principles, which make up the theoretical contribution of the study, and product implementation, or the practical results of the study (cf. McKenney & Reeves, 2012; Plomp, 2009). The results of one phase feed into the next phase. In this study, we based the problem analysis on existing information about the status of technology integration in education in Tanzania (Hare, 2007; Kalinga, 2008; Mwalongo, 2011; Swarts & Wachira, 2010).

The study reported in this chapter was a proof of concept study in which a professional development arrangement that incorporates ‘learning technology by design’ was conducted with pre-service teachers. Based on studies conducted in similar contexts, one by Agyei (2012) in Ghana and one by Alayyar (2011) in Kuwait, the concept of collaborative design in teams was applied to pre-service teachers training in Tanzania. A context-based professional development arrangement was designed, whereby pre-service teachers participated in a workshop, collaborated in teams to design technology-enhanced science and mathematics lessons, taught the designed lessons to peers through microteaching, and reflected upon the lessons with peers. Unlike professional development arrangements consisting of workshops and/or seminars only, which are commonly implemented in Tanzania (Komba & Nkumbi, 2008), the study reported in this chapter adopted collaborative design in teams (cf. Voogt et al., 2011) as a professional development strategy. Collaborative design in teams is considered to be an effective professional development strategy because it situates teachers’ professional development in a meaningful context, allowing teachers to actively engage in the learning process, and providing opportunities for shared ideas through collaboration (Voogt et al., 2011). The professional development arrangement presented in this study adopted the “plan, teach, evaluate, re-plan” approach as proposed by Peker (2009) for pre-service teachers. This approach was implemented by Jimoyiannis (2010) for in-service teachers as “planning, development, evaluation and rethinking”. Unlike

Peker (2009) and Jimoyiannis (2010), who began their programs with planning, the professional development arrangement presented in this study began with an introductory workshop to introduce the concept of technology integration in science and mathematics teaching, followed by collaborative design in teams (planning), lesson implementation (teaching), reflection (evaluation) and re-design (re-plan) (Table 8.1).

Thus, this study was conducted to test the effectiveness of this professional development arrangement in the context of the Tanzanian educational system. TPACK was used as a conceptual framework to articulate what was involved in teachers' technology integration knowledge and skills. The study included gathering self-reported and observational data on the pre-service teachers' technology integration knowledge and skills, and their reflection on the intervention activities.

Findings

Findings showed a significant and positive change in Technological Knowledge, Technological Content Knowledge, and Technological Pedagogical Content Knowledge, between pre- and post-intervention, with medium effect sizes. The changes in the remaining TPACK components (Content Knowledge, Pedagogical Knowledge, Pedagogical Content Knowledge, and Technological Pedagogical Knowledge) were insignificant. Peer-rated observation results showed a positive significant change in all technology-related components of TPACK between

Table 8.1 Professional development arrangement

Components	Activities	Duration
Workshop	Introduction of the concept of technology integration in teaching, technological tools that can support learning and the concept of collaborative design in teams	2–4 days with up to 6 hours training per day
	Hands-on activities on how to design technology-enhanced science and mathematics lessons in teams	
Collaborative design in teams	Collaborative design of technology-enhanced science and mathematics lessons	3–4 weeks
	Team meetings were held three times a week for 2–3 hours per day	Three times a week, for 2–3 hours per day
Lesson implementation	Teaching the designed lessons in the classroom	80 min for each team
	One team member taught the lesson while others were moving around the classroom to support the students	
Reflection	Reflection with peers and the expert on the lessons designed	1 day
	Discussion of how to improve the next lesson	
Lesson re-design	Re-design of technology-enhanced lessons to incorporate the ideas discussed during the reflection	3–4 weeks

pre- and post-intervention results. The significant increase in the technology-related components of TPACK confirmed that the professional development arrangement helped teachers to develop their technology integration knowledge and skills. The small increase in Content Knowledge and Pedagogical Content Knowledge could be an indication that the professional development arrangement also helped the teachers to better understand the content they were teaching and the teaching approaches they were applying in teaching this content. An unexpected outcome was that pre-service teachers rated their Pedagogical Knowledge lower at the post-test than at the pre-test. The unexpected small decrease in Pedagogical Knowledge could be an indication that the professional development program made the pre-service teachers aware that their Pedagogical Knowledge was lower than they had initially thought.

The professional development arrangement adopted in this study provided the pre-service teachers with hands-on experience in designing and teaching technology-enhanced lessons. Pre-service teachers were exposed to two important innovations. The first was the opportunity to experience collaborative design and teaching of technology-enhanced lessons in a way that reflected actual classroom teaching. This was important in developing the pre-service teachers' practical experience with the use of technology in designing and teaching science and mathematics subjects. The second was the opportunity to think about technology integration by using TPACK as a conceptual framework. By developing conceptual understanding of TPACK, pre-service teachers were able to integrate technology with science or mathematics and with pedagogy. The opportunity to practice the integration of technology in a way similar to the real classroom, to work in teams and to reflect on their practices is lacking in most teacher training colleges in Tanzania. This study demonstrated the need for authentic learning activities to train pre-service teachers to adequately and effectively integrate technology into their future classrooms.

The findings from this study further confirmed the findings in Ghana and Kuwait (see above) that collaborative design in teams is an effective professional development arrangement for developing technology integration knowledge and skills among pre-service science and mathematics teachers.

Conclusion and Discussion

This study was conducted to investigate the impact of pre-service and in-service teachers' participation in the collaborative design of technology-enhanced lessons as a professional development arrangement for developing knowledge and skills for integrating technology into their science and mathematics teaching. The study emerged from the long-existing problem of low uptake of technology by science and mathematics teachers in Tanzania, and the main research question was answered through a study conducted to test, refine, implement, and evaluate the impact of the professional development arrangement.

Before participation in the professional development arrangement, pre-service and in-service teachers had sufficient Pedagogical Knowledge, Content Knowledge and Pedagogical Content Knowledge, but limited Technological Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, and TPACK. Thus, emphasis was required on the technology-related component of TPACK in order to develop teachers' knowledge and skills for integrating technology into their science and mathematics teaching.

The low uptake of technology in schools in Tanzania is a result of teachers' poor conceptual understanding of technology integration in teaching (lack of TPACK), lack of practical experience with technology, and lack of collaboration among teachers. Although teacher training colleges in Tanzania do prepare teachers to use technology in their teaching, a framework describing the knowledge base that teachers need to develop for effective integration of technology into their teaching is missing. Additionally, pre-service teachers have limited opportunities to practice the integration of technology in teaching (cf. Forkosh-Baruch, 2018; Tondeur, Pareja Roblin, van Braak, Fisser, & Voogt, 2013). Moreover, collaboration for learning is lacking in most of the teacher training colleges and schools.

The adoption of collaborative design in teams as a professional development arrangement improved both teachers' self-reported and their observed knowledge related to integrating technology into their science and mathematics teaching. Through collaborative design in teams, teachers reported sharing knowledge, skills, experiences and challenges, and thus, learning from each other. In the teams, teachers also reported reminding each other about the concepts they had learned from the workshop. Findings further showed that collaborative design in teams was effective when teachers were supported through collaboration guidelines, exemplary lessons, online learning materials and an expert with experience in science and education technology.

The long-term impact of the professional development arrangement adopted in this study in the context of the Tanzanian educational system depends on teachers' technology integration knowledge and skills, access to technology, and the ease of use of the available technology. A conceptual model for the continued use of technology in teaching that was developed in this study considers the continued use of technology to be determined by the teachers' professional development, knowledge and skills, access to technology and ease of use of technology. In this model, the professional development, either during the teacher education program (pre-service teachers) or during an in-service arrangement (practicing teachers) is considered to be the initiator of the change in teachers' knowledge and skills for integrating technology into their teaching, which leads to effective use of the available technology in teaching, provided that the available technology is easy to use. Support from the school management is considered to be a catalyst for teachers' use of the technology available at their school for teaching, after participation in the professional development arrangement.

Unlike other design research in which the identification of the problem happens through conducting a feasibility study or situational analysis study (cf. Agyei, 2012; Bakah, 2011; Nihuka, 2011), our research began with a *proof of concept study* in which problem identification was based on previous studies and an in-depth review of literature. According to Plomp (2009), "informed by prior researches and review of relevant literature, researchers in collaboration with practitioners can design and develop workable and effective interventions by carefully studying successive versions (or prototypes) of interventions in their target contexts, …" (p. 13). From the literature it was seen that although technology was available in schools in Tanzania, and teacher training colleges were training teachers to integrate technology into their teaching, technology uptake in schools was low. Thus, a proof of concept study was conducted to find out whether the professional development approach that had been successful in Ghana (Agyei, 2012) and Kuwait (Alayyar, 2011) could also be applied successfully in Tanzania to develop teachers' technology integration knowledge and skills.

Proof of concept studies are common in clinical research and are used synonymously with pilot studies. In clinical research these kinds of studies are used to determine whether a treatment is biologically active or inactive (Thabane et al., 2010). Similarly, in this research, a proof of concept study was conducted to determine whether collaborative design in teams is a feasible and effective approach for developing technology integration knowledge and skills among science and mathematics teachers in Tanzania.

One of the characteristics of design research put forward by McKenney and Reeves (2012) is the complex nature of its interventions, typically consisting of several parts (activities). Little is therefore known about the contribution of each of the activities making up the intervention. In this study, the IMPG model (Clarke & Hollingsworth, 2002) was used to untangle the contribution of each of the components of the intervention to the teachers' development of technology integration knowledge and skills. This helped to explain the importance of each activity that was incorporated in the professional development arrangement presented in this study (i.e., collaborative design in teams, lesson implementation, reflection, and support).

References

Agyei, D. (2012). *Preparation of pre-service teachers in Ghana to integrate Information and Communication Technology in teaching mathematics* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Agyei, D. D., & Voogt, J. M. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology, 28*(4), 547–564.

Alayyar, G. (2011). *Developing pre-service teacher competencies for ICT integration through design teams* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Alayyar, G., Fisser, P., & Voogt, J. (2011). ICT integration through design teams in science teacher preparation. *International Journal of Learning Technology, 6*(2), 125–145.

Allan, C. W., Erickson, J. L., Brookhouse, P., & Johnson, J. L. (2010). EcoScienceWorks: Teacher professional development through a collaborative curriculum project – An example of TPACK in Maine. *TechTrends, 54*(6), 36–43.

Bakah, M. A. (2011). *Teacher professional development through collaborative curriculum design in Ghana's polytechnics* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education, 24*, 417–436.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*, 947–967.

Ferrini-Mundy, J., & Breaux, G. A. (2008). Perspectives on research, policy, and the use of technology in mathematics teaching and learning in the United States. In G. W. Blume & M. K. Heid (Eds.), *Research on technology and the teaching and learning of mathematics: Volume 2. Cases and perspectives* (pp. 427–448). Charlotte, NC: Information Age Publishing.

Forkosh-Baruch, A. (2018). Preparing pre-service teachers to transform education with information and communication technologies. In J. Voogt, G. Knezek, R. Christensen, & K.-W. Lai (Eds.), *Second handbook of information technology in primary and secondary education* (Springer International Handbooks of Education) (pp. 415–432). Cham, Switzerland: Springer.

Guzey, S. S., & Roehrig, G. H. (2009). Teaching science with technology: Case studies of science teachers' development of technology, pedagogy, and content knowledge. *Contemporary Issues in Technology and Teacher Education, 9*(1), 25–45.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design team* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Hare, H. (2007). Survey of ICT in education in Tanzania. In G. Farrell, S. Isaacs, & M. Trucano (Eds.), *Survey of ICT and education in Africa (volume 2): 53 country reports*. Washington, DC: infoDev/World Bank.

Hooker, M., Mwiyeria, E., & Verma, A. (2011). *ICT competency framework for teachers in Tanzania: Teacher development for the 21st century (TDev21) pilot*. Dar es Salaam, Tanzania: Ministry of Education and Vocational Education, Tanzania.

Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers' professional development. *Computers & Education, 55*, 1259–1269.

Kalinga, E. A. (2008). *Development of an interactive e-learning management system (e-lms) for tanzanian secondary schools* (Doctoral dissertation). Karlskrona, Sweden: Blekinge Institute of Technology.

Keong, C., Horani, S., & Daniel, J. (2005). A study on the use of ICT in mathematics teaching. *Malaysian Online Journal of Instructional Technology, 2*(3), 43–51.

Koehler, J. M., Mishra, P., Bouck, E. C., DeSchryver, M., Kereluik, K., Shin, T. S., et al. (2011). Deep-play: Developing TPACK for 21st century teachers. *International Journal of Learning Technology, 6*(2), 146–163.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60–70.

Koehler, M., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*, 740–762.

Komba, W., & Nkumbi, E. (2008). Teacher professional development in Tanzania: Perceptions and practices. *Journal of International Cooperation in Education, 11*(3), 67–83.

McKenney, S., & Reeves, T. (2012). *Conducting educational design research*. London: Routledge.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mishra, P., & Koehler, M. (2008). *Introducing technological pedagogical content knowledge*. Paper presented at the annual meeting of the American Educational Research Association, New York City.

Mwalongo, A. (2011). Teachers' perceptions about ICT for teaching, professional development, administration and personal use. *International Journal of Education and Development using Information and Communication Technology, 7*(3), 36–49.

Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper, S. R., Johnston, C., et al. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education, 9*(1), 4–24.

Nihuka, K. (2011). *Collaborative course design to support implementation of e-learning by instructors* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Özgün-Koca, S. A., Meagher, M., & Edwards, M. T. (2010). Pre-service teachers' emerging TPACK in a technology-rich methods class. *The Mathematics Educator, 19*(2), 10–20.

Peker, M. (2009). The use of expanded microteaching for reducing preservice teachers' teaching anxiety about mathematics. *Scientific Research and Essay, 4*(9), 872–880.

Plomp, T. (2009). Educational design research: an introduction. In T. Plomp, & N. Nieveen (Eds.), *An introduction to educational design research*. Proceedings of the seminar conducted at the East China Normal University, Shanghai (PR China) November 23–26, 2007 (pp. 9–36). Enschede, The Netherlands: SLO.

Plomp, T., Anderson, R. E., Law, N., & Quale, A. (2009). *Cross-national information and communication technology: Policies and practices in education* (2nd ed.). Charlotte, NC: Information Age Publishing.

Reeves, T. (2006). Design research from a technology perspective. In J. Van den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 52–66). New York: Routledge.

Richardson, S. (2009). Mathematics teachers' development, exploration, and advancement of technological pedagogical content knowledge in the teaching and learning of algebra. *Contemporary Issues in Technology and Teacher Education, 9*(2), 117–130.

Riveros, A., Newton, P., & Burgess, D. (2012). A situated account of teacher agency and learning: Critical reflections on professional learning communities. *Canadian Journal of Education, 35*(1), 202–216.

Senzige, J. P., & Sarukesi, K. (2004). An approach to ICT-based school education in Tanzania. *African Journal of Finance and Management, 12*(2), 88–97.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Simmie, G. M. (2007). Teacher Design Teams (TDTs): Building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. The entity from which ERIC acquires the content, including journal, organization, and conference names, or by means of online submission from the author. *Irish Educational Studies, 26*(2), 163–176.

Swarts, P., & Wachira, E. M. (2010). *Tanzania: ICT in education: Situational analysis*. Dar-es-Salaam, Tanzania: Global e-School and Communities Initiative.

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L. P., et al. (2010). A tutorial on pilot studies: The what, why and how. *BMC Medical Research Methodology, 10*(1), 1–10.

Thompson, A. D., & Mishra, P. (2007–2008). Breaking news: TPCK becomes TPACK! *Journal of Computing in Teacher Education, 24*(2), 38–39.

Tondeur, J., Pareja Roblin, N., van Braak, J., Fisser, P., & Voogt, J. (2013). Technological pedagogical content knowledge in teacher education: In search of a new curriculum. *Educational Studies, 39*(2), 239–243. https://doi.org/10.1080/03055698.2012.713548

URT. (2009). *A framework for ICT use in teacher professional development in Tanzania*. Dar es Salaam, Tanzania: Ministry of Education and Vocational Training.

Van den Akker, J. (1988). The teacher as learner in curriculum implementation. *Journal of Curriculum Studies, 20*(1), 47–55.

Vesisenaho, M. (2007). *Developing university-level introductory ICT education in Tanzania: A contextualized approach* (Unpublished doctoral Dissertation). Joesnsuu: University of Joensuu.
Voogt, J. (2010). A blended in-service arrangement for supporting science teachers in technology integration. *Journal of Technology and Teacher Education, 18*(1), 83–109.
Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge – A review of the literature. *Journal of Computer Assisted Learning, 29*, 109–121.
Voogt, J., Tilya, F., & Van den Akker, J. (2009). Science teacher learning for MBL-supported student-centered science education in the context of secondary education in Tanzania. *Journal of Science Education and Technology, 18*, 429–428.
Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235–1244.
Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5–23.
Webb, M. (2008). Impact of IT on science education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 133–148). New York: Springer.
Wentworth, N., Graham, C. R., & Tripp, T. (2008). Development of teaching and technology integration: Focus on pedagogy. *Computers in the Schools, 25*, 64–80.

Part III
Design and Implementation: Editorial Introduction

Curriculum Design: Teacher's Involvement

A common strategy used by schools to realize educational reform is the organization of teacher teams. Using cases from the Netherlands, Kuwait and Ethiopia, in the current section we elaborate on the competences such teacher teams need to engage in collaborative curriculum design and the activities they undertake in order to realize curriculum reform.

The study by Adam Handelzalts reported in the first chapter of this section aimed at describing the development of such teacher teams in lower secondary education, the type of curriculum design activities they undertake in the context of a school-based reform ambition, and ways to support their efforts. Teacher design teams in two different schools were followed during their 1st year of collaboration. Their activities were documented, teachers were interviewed and observed and (curriculum) documents produced by teacher design teams were collected and analyzed. This systematic documentation process and the perspective of the practitioners formed the basis for detecting activities and conditions that had a special (positive or negative) function for the teams. These activities and conditions are presented and discussed.

The second chapter by Tjark Huizinga, Nienke Nieveen and Adam Handelzalts focuses on implementation activities in teacher design teams (TDTs), and the opportunities these provide to develop teachers' curriculum design expertise. Specifically, the implementation activities of three TDTs that renewed their foreign language curriculum were investigated using a case study approach. The results showed that although TDTs carried out a wide variety of activities to foster classroom implementation, classroom use of the new curriculum materials varied. The need for additional support for TDTs in the implementation process in order to successfully facilitate changes in teachers' classroom practices is discussed.

The study by Ghaida Alayyar and Petra Fisser discusses the potential of blended support for learning in teacher design teams for ICT integration in the context of the pre-service science teacher education program at the Public Authority of Applied

Education and Training (PAAET) in Kuwait. A major problem in the pre-service teacher education curriculum of this institution was the way pre-service science teachers were prepared to use ICT in their teaching. To tackle this problem, Technological Pedagogical Content Knowledge (TPACK) was used as a conceptual framework to prepare students in the science teacher preparation program for using ICT in their teaching. In the first iteration of the intervention students worked in design teams and were coached by technology, pedagogy, and content experts, to find a technological solution for a pedagogical problem that a teacher normally faces. In the second iteration students were offered an electronic support environment in addition to the expert support. As a result of the intervention, students had a positive attitude towards ICT and towards working in design teams. By adding the electronic support environment, the increase in student teachers' positive attitude towards the use of ICT was even larger, as well as the increase in their knowledge about the pedagogical use of ICT in teaching. Implications for preparing pre-service students in ICT integration as part of their curriculum are discussed.

The study by Anto Arkato Gendole and Fer Coenders reported in the final chapter of this section investigated the effects of facilitator and peer support in collaborative curriculum design on English language teachers' practice and learning of Communicative Language Teaching (CLT) and their students' motivation. Both types of support had promising effects on teaching practice, student motivation, and CLT knowledge and beliefs of teachers. Quantitative data analysis showed that teachers supported by peers had significantly better gains in their general CLT practice, but qualitative data analysis showed more comparable teacher learning gains across the two support groups. The study supported the conclusion that professional development in which teachers are supported by peers or facilitators in enacting innovative teaching practices seems promising.

Chapter 9
Collaborative Curriculum Development in Teacher Design Teams

Adam Handelzalts

Introduction

School-Based and School-Wide Curriculum Reform

The reform literature provides many motives for planning reform in a school-based and school-wide manner. The school-based line of reasoning calls for a central role for and commitment by teachers and other practitioners in the reforming of teaching practice (Clandinin & Connelly, 1992; Skilbeck, 1998). As curriculum reform is highly dependent on the teachers who will eventually realize it, they must be engaged in the reform process. The teachers are also the ones with intimate knowledge of everyday practice and the needs of their students. This knowledge is crucial for the realization and success of any reform.

The school-wide line of reasoning is more concentrated on strengthening reform by making it a shared practice across the school (Grossman, Wineburg, & Woolworth, 2001; Hord, 2004), and in doing so, realizing sustainable, significant, and coherent educational reform in schools and between the teachers. The school-wide approach is essential for transforming reform from an incidental and isolated process in one part of the school, towards being a sustainable and coherent change for the whole school. The proponents of the school-wide approach state that many innovation plans fail at an early stage, and when an attempt does succeed, it is often an isolated effort by a few teachers embracing a reform. In the long run, most curriculum innovations and projects that rely on individual teachers' voluntary commitments do not last (Hargreaves, 2003). Therefore, there is a need to organize reform in a school-wide manner in which all teachers are somehow involved.

A. Handelzalts (✉)
Teacher Education Department, Free University, Amsterdam, The Netherlands
e-mail: a.handelzalts@vu.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_9

An implication of the change in orientation (aiming at coherent and school-wide sustainable reform) is that there is a need for synergy and productive relationships at various levels (system, school, and classroom) between curriculum development, professional development of teachers, and school development. This synergy of processes is key for sustainable reform (cf. Fullan, 2007; Hopkins, 2001). Curriculum development and reform can be seen as the central elements of this trio as they touch directly on the learning of students, the daily work of teachers and their interaction with the students, and the way learning is organized in the school as a whole. Policy reform in Dutch lower secondary education is specifically aimed at changes in schools' curriculum. However, as curriculum reform, teacher development, and school development interact, all of them must be addressed. This puts the teachers at the forefront of curriculum improvement as they are central agents in all of these areas of development. As it is, teachers have a central role as curriculum makers of their school-based curriculum (Clandinin & Connelly, 1992; Skilbeck, 1998). Additionally, focusing on improving the curriculum is also intrinsically motivating to teachers. In contrast to broader organizational issues that are not always perceived as relevant to their direct practice, planning the actual learning processes of their students in their own subject matter domain is appealing to them (cf. Black & Atkin, 1996; Grossman & Stodolsky, 1995). Moreover, Skilbeck (1998) argued that teacher participation in curriculum development potentially helps to improve the quality and relevance of what is taught and will strengthen teacher professionalism.

Educational reform processes in which a large group of teachers are actively involved that are focused on curriculum as a main driver of change in a school-wide context seems to be the advisable move forward. But realizing this kind of work is far from easy (as schools have reported) as it involves curriculum development activities in collaboration between teachers, the participants' learning process, and changes at the school level. Although these types of integral activities have already taken place in some schools on various levels, it is far from being a common phenomenon and only a few schools have experience with it. Moreover, schools that try this kind of work have reported many tensions concerning the work at the school level, and the relationship between the school level and the various teams of teachers within it. In view of its promise and growing popularity, the school-wide and school-based approach in Dutch school-reform practice forms the context in which this study was conducted.

Teacher Teams in Curriculum Reform

Insights from the reform literature support teacher collaboration in teams as a fruitful means for educational reform. The recent literature has maintained that teacher collaboration in the form of, for example, 'professional learning communities' is a central element in achieving sustainable school reform (e.g., Hord, 2004; Lieberman & Miller, 2004; McLaughlin & Talbert, 2001, 2006). In fact, one of the problems of school reform is that most teachers teach alone in isolated classes without having (or taking) the opportunity to reflect together on their teaching practices, to introduce new perspectives, to discuss new ideas, to give each other feedback on improvement efforts, and to jointly develop new initiatives. Schools that aim at innovation thus need to organize teacher collaboration centered on their teaching practice (Little, 1990). Collaboration between teachers is expected to have an impact on practice. There is considerable research showing that collaborative teacher teams are beneficial for student learning, which is the bottom line of educational quality (Louis & Marks, 1998; McLaughlin & Talbert, 2006). Collaborative teams have the most impact on student achievement when the focus of the work shows a persistent link to student learning and the initiatives taken are directly related to curriculum and instruction (Sackney, Mitchell, & Walker, 2005; Vescio, Ross, & Adams, 2008). Grossman et al. (2001) went even further and suggested that teachers need common curriculum experience in their collaboration (either by teaching together or observing each other teaching) in order to achieve effective collaboration that influences students' achievement.

Teachers' participation in development processes and in implementing the curricular products in practice can also be beneficial for teacher learning. When designing their future practice, teachers build on their current practice and adapt it in relation to their needs and wishes. By piloting the design product and by reflecting on the experiences and results, teachers can become aware of the specific potentials and problems of the reform. Based on such systematic reflections, they will gain new insights for the design. This can lead to yet another cycle of design, evaluation, and reflection. This learning process is an important part of the curriculum reform and development process, because in many curriculum changes a shift in teacher beliefs, roles, and methods is essential (Fullan, 2007). Adding these arguments to the strength of the curriculum perspective in school reform discussed in the previous section leads to a strong argument to concentrate teacher collaboration in schools on curriculum planning.

Considering the potential and appearance of teacher teams that concentrate on curriculum (design), there are only a few clear guidelines as to how these teams should pursue their curriculum development task. Although there is much research on teacher communities and teacher collaboration in the context of the school (cf. Henze-Rietveld, 2006; Meirink, Meijer, & Verloop, 2007; Zwart, Wubbels, Bergen, & Bolhuis, 2007), the focus is mostly on the forming of communities and the teachers' learning process. Little research is available on the curriculum design processes of teacher teams within schools and the kind of activities and conditions that contribute to the success of such processes. Moreover, most research deals with the input and output of these kinds of collaborative teams and there is still little known about how these teams get off to a good start and are sustained in their design work (McLaughlin & Talbert, 2006).

School-Based and School-Wide Curriculum Reform in Lower Secondary Education in the Netherlands

During the early years of the twenty-first century a central element of the changes in lower secondary education in the Netherlands was school-based reforms. Schools were central in deciding on substantial elements of their reform. Influenced by this expanded autonomy, by 2007, 93% of all schools for lower secondary education were reported to be engaged in or about to start renewing their school-wide curriculum and school-wide organization, led by their own curriculum preferences and possibilities (Onderbouw-VO, 2008). Within this innovation trend there was great variety, with some schools choosing modest pedagogical changes in the existing subjects, others introducing interdisciplinary learning-projects, and some (newly opened) schools going as far as to radically give up the division of learning into subject areas by offering an alternative organization of the curriculum (Hendriks, 2004; Onderbouw-VO, 2007, 2008).

Many schools also approached their reform efforts from a school-wide perspective. In order to realize curricular coherence, they initiated reforms that concerned the whole breadth of the curriculum in the school. This meant a departure from the traditional and somewhat fragmented structure and work process of secondary education in The Netherlands. Until then, secondary schools had been mainly organized in vertical subject departments covering all grades (lower and higher secondary) which to a large extent functioned autonomously when setting their educational courses, with little substantive coordination with other departments.

Although these developments were evident in the Dutch context, schools encountered difficulties in engaging in these processes. The most noted difficulties were a lack of time and resources for work on the reforms (57%); negative attitude of teachers towards the reform (42%); and teachers' lack of knowledge and therefore difficulties in participation (27%). Another notable result was the reported differences experienced between what teachers aimed for and the more ambitious and far-reaching goals expressed by the school management (26%) (Onderbouw-VO, 2008). All of these hindering factors were keeping schools busy as they tried to realize the reforms in lower secondary education.

A strategy lower secondary schools in the Netherlands applied to realize curriculum reform was organizing teams of teachers who are responsible for specific curricular domains (for example, 'The Humanities' or 'Foreign languages'). In 2007, 59% of the schools reported that they had organized at least some of the reform efforts in the form of these teacher teams from adjacent subjects who were responsible for redesigning their common subjects or interdisciplinary learning-projects. By the year 2012, 87% of schools were expecting to work in this manner (Onderbouw-VO, 2008). This phenomenon was mainly driven by practical reasoning. First, these teams bridged the gap between the aspirations at the school-level on the one hand, and the aspirations and practice of individual teachers on the other. Working in teams can help teachers translate the school-level ambitions to concrete materials, lessons plans, and eventually to teaching. Having an active role in creating the reform also enables the teachers to enact their own wishes and plans in the school curriculum. Second, the inclination for teacher cooperation was part of the drive for achieving coherence, which was central to the lower secondary reform. Schools and teachers were searching for ways to integrate parts of their curriculum and create fruitful connections between subject domains. This manner of realizing school-wide curriculum reform was a relatively new phenomenon in the Dutch educational policy field and called for further exploration.

The decentralized Dutch educational policy climate enabled schools and teacher teams to take an active part in curriculum development and therefore made extensive study of the work of the teams possible. The study reported in this chapter aimed at describing the development of such teacher teams (hereafter referred to as Teacher Design Teams), the type of curriculum design activities they undertake in this context, and ways to support their efforts.

Defining Teacher Design Teams

The main focus of this study was a specific form of teacher collaboration in curriculum design, the Teacher Design Team (TDT). A TDT is defined as a group of at least two teachers, from the same or related subjects, working together on a regular basis, with the goal to (re)design and enact (a part of) their common curriculum (Handelzalts, 2009).

The defining characteristic of a TDT is its specific and central design task; the main goal of TDTs is to (re)design their common curriculum. The teachers' teams usually described in literature (i.e., professional learning communities, communities of practice) mostly focus on improving their teaching process through the professional development of the teachers. In the case of the TDT, the goals of professional development or building of cohesion in the staff are seen as secondary to the main design goal. These secondary goals play a role in the work of the TDT, but are seen as contributing factors to realizing a better curricular product. In some instances a TDT can also be seen as a professional learning community, but that is not necessarily the case.

Another central element of the TDT is collaboration of several teachers concerned with (re)designing their curriculum. Such collaboration effort is seen as a crucial factor for sustainable change that is effective at the student level (McLaughlin & Talbert, 2006). The characteristic of involving related subjects, in this respect, emphasizes the fact that teachers need to have some common ground on which they collaborate. The extent of the relationship can vary according to the perceptions of the teachers in the specific context. They are the ones considering this, and if they can see a relationship with another subject (for example, between geography and history), then these are considered 'related subjects'. This characteristic is related to the research context, the reform in the Dutch lower secondary education. A large part of the reform is aimed at creating more connections between different subjects in order to create more coherence in the curriculum. Finally, TDTs develop their common future practice and enact upon it. This emphasis separates TDTs from teachers' teams that develop curricula but not for their own use (such as, for example, teachers participating in the development of learning materials with publishers). Collaboration in design of materials that the teachers themselves will use, and that will therefore affect their practice directly, raises their stakes in the process and the ownership of the product. This is also in line with a central tenet of this study: reform efforts have greater effect when they are school-based.

A TDT is an ad hoc functional unit, meaning that it is not an organizational entity on its own, but rather a description of how a team of teachers functions within a time frame. For example, a subject department at a school can, during a certain period, function as a TDT when they consciously redesign their common curriculum. As soon as this task is no longer central in their work, they will not be considered as a TDT anymore.

The focus in this study is specifically on teams in their first year of co-operation, as it seems that patterns of collaboration in design and design-related decisions tend to be formed in the initial stages of the work. These patterns are then perpetuated during the rest of the design process. According to Romme and Endenburg (2006), early choices and notions create boundaries around subsequent stages in the development. The design process can be divided into 'fluid' and 'crystallized' states. During the fluid state the problem and its solution strategy are still open to many directions. Once it is crystallized, the ability to revise key elements of the design without incurring extra costs (monetary or otherwise) is greatly reduced.

Research Questions

This study started from the premise that teacher collaboration in curriculum development is well-placed in order to bridge the gap between school-level curriculum reform and classroom-level practices. As teachers are at the forefront of all educational reforms, they need not only to be involved in the implementation process, but also to be active participants in the development process of the reform. It is assumed that collaboration between teachers in these curriculum development efforts enables (1) more coherent curriculum development across teachers and subjects, (2) teacher professional development, and (3) development of the school organization as a whole.

This study intended to contribute to this knowledge base by studying TDTs in their first year of development work. The main research question guiding this study was as follows:

> What are conducive (or hindering) approaches and conditions for collaborative curriculum development by teacher design teams in view of school-wide reform?

This research question was further divided into three sub-questions: the first aimed at describing the work of teacher design teams, the second concerned those activities that were specifically conducive or hindering to the teams in striving towards their goal of a common curriculum, and the third aimed at exploring the school conditions that promoted or hampered these efforts.

Method

Collaborative curriculum design takes place within the context of schools. Therefore this study was conducted as multiple case study research. According to Yin (2003), case study research is suitable specifically when the borders between a phenomenon and its context cannot be clearly drawn. The focus of the research was on the teacher teams, who formed the cases in redesigning their common curriculum. Each case was built around one of the teams followed in the study. The cases included the activities and development in the team during this redesign, the organizational conditions that they were confronted with, and their interaction with their professional environment during the course of the reform.

Twelve teacher design teams in two different schools (seven teams in one school and five teams in another school) were followed during their first year of collaboration, the preparation year. The choice was made of teams that are neither very early nor very late adopters of new practices. Teams were not experiencing very extreme circumstances (such as very bad collegial relationships), as such teams will present other challenges.

During this first year, many of the TDTs' activities were documented, teachers were interviewed and observed, both at the start and at the end of the study, and (curriculum) documents produced by the TDTs were collected and analyzed. Based on the data, a rich description of the teams' work was obtained. This systematic documentation process and the perspective of the practitioners formed the basis for identifying activities and conditions that had a special (positive or negative) function for the teams. The analysis of the findings, based on the three sub-questions guiding this study, was done on three levels: (1) an analysis of the individual cases (the teams), resulting in detailed case descriptions; (2) a cross-case analysis of the teams in each of the schools to find common and divergent patterns per school; (3) a cross-study analysis, comparing the findings from the two school sites to detect commonalities and differences between the school sites. By choosing these schools and teams carefully and by comparing the findings with other studies, some analytic generalization can be made to TDTs in other contexts.

Main Findings

How TDTs Addressed and Carried Out Their Development Work

With regard to the work of the TDTs, it became obvious that it was neither explicitly planned nor organized by any player in the process (in most cases, not even by the external coaches). Teams most often proceeded from one meeting to the next tackling issues as they arose. This implied that only a (small) portion of their curriculum materials were ready at the end of the preparation year for almost all the teams. Role division in most teams was informal and not all teachers participated to the same extent in the curriculum development activities. Most of the joint work was concentrated on developing general design decisions. There was little joint work on constructing concrete teaching and learning materials. On those occasions where collaboration on constructing concrete materials level did occur, this led to realizing more significant changes in the team's curriculum.

In the first phase of their work, teams were very much oriented towards the future 'time' and 'place' components of their curriculum. These issues needed to be somewhat clarified before the team was open to discussing more fundamental curricular questions such as 'content', 'teaching activities', and 'materials'. The major design decisions that teams made in their curriculum development process were done either during the first several meetings of the TDTs or even prior to the commencement of the formal process in school (teams that had already some common plans and had not yet had the chance to realize them took the opportunities provided by the reform process). This underlines the importance of this initial phase.

The overall process of the teams included only a few of the 'ideal' steps in curriculum development. While analysis activities were somewhat apparent (mainly oriented towards the organizational aspects), design and construction seemed to occur most often simultaneously. TDTs spent little time on the issues of 'rationale' and 'goals'. These issues rarely come up in an unprompted discussion. Even when a coach introduced those issues, teachers found this discussion difficult and abstract. Teams conducted little to no explicit evaluation activity and judged the quality of their plans and materials mainly on the basis of their practicality.

The teachers' main substantive consideration in the development of their curricula was the content that should be taught. Content was then defined as what the textbooks contain. This was, however, not a critical discussion of content selection but more an issue of content coverage. Cross-curricular teams were the only teams in which content was more critically discussed.

TDTs displayed a clear pattern in which general design discussions were conducted together, whereas construction of materials was an individual exercise done at home with little feedback between the team members. The teams experienced working individually on the construction of teaching materials as one of the most efficient parts of the work, as it was related to a feeling of real progress in their work. Joint work seemed limited to general issues and design statements.

Conducive or Hindering Activities

The most conducive activities were those that assisted in creating a visualization of the future practice of the reformed curriculum. The activities (such as piloting, school visits, and discussion of blueprints of design) were highly valued by the teachers and led to pattern changes in the teams' process.

Teams with a clear common reform ambition and a positive disposition towards the reform started more rapidly with their design and were less dependent on the clarity of the reform. Teams with vague reform ambitions and ambivalence towards the reform needed sufficient clarity about the organizational conditions of their future practice before starting to work on their concrete plans. For these latter teams, this led either to a long analysis and orientation phase followed by a brief design phase or to a long period of inactivity followed by a brief burst of design and construction activities. These activities then were mainly aimed at adjusting former curricula to the organizational conditions of the school reform.

On the whole, it seems that the teams that shared clear initial ambitions often realized explicit incorporation of the school-wide reform goals in their products. Teams that decided to keep their former textbooks and to use them as part of their reform chose in general to continue their existing teaching approach with little change. Thus, this might be considered a hindering approach, as it meant that they often did not even reconsider their former practice.

Teams with vague or no common ambition showed a greater dependency on the level of clarity of the reform. These teams made, on the whole, less progress in the production of new curriculum plans and materials. When the school-wide process was more structured, this lack of clarity had less impact on the pace of the work of the teams. In both schools, the school-wide process gave only few organized opportunities for interaction between TDTs. However, teachers often expressed a need for such opportunities and when such activities did take place, they had a strong impact on the teams. These kinds of activities gave teams an overview of the developments at the school level. It also supported the commitment of the teachers to the process, as it strengthened the impression of a shared endeavor and identification with the work of other teams in the same school.

Conditions at School Level

Much of the TDTs' work was accomplished during a brief period of time in which the teams met on a regular basis, during which they made the most progress. However, this is not the dominant pattern of work, as TDTs seemed to meet irregularly. A centrally scheduled regular meeting roster and allocated time are necessary but not sufficient for enabling meetings.

The perceived effectiveness of coaching was dependent on the ability of the coach to cater to the main needs of the TDT, especially in creating or providing concrete tangible teaching materials. The presence of a coach also had a crucial role in triggering team meetings by making concrete appointments and suggesting discussion issues.

In both school sites followed in this study the work of the TDT was the responsibility of a member of the school management team. In one case it was the innovation manager, in the other the school section leaders. Findings showed little differentiation in the manner in which these school leaders approached the different teams, while the teams showed great variation in their work. The school leaders had only a vague overview of the progress of the TDTs, as there was little interaction with the teams concerning their work. The importance of this issue was demonstrated when the school management did actively inquire about the development of the TDTs' work. This single incident had a positive impact, leading to increased curriculum development activity and materials construction by the TDTs. It supplied teams with information and had a relational function. All teams found the interest and time investment of the leader important.

Overall Conclusions

Taking into account the findings along with the insights from other studies, several conclusions can be drawn. These conclusions are related partly to how TDTs go about the process of curriculum development and partly to the activities and conditions that seem to be conducive for their work.

The Process of Curriculum Development

TDTs display a great variation of activities and experiences within a similar reform context (see also Voncken, Derriks, & Ledoux, 2007). In large part, these variations can be accounted for by the characteristics of the teams and their interaction with the school-wide reform.

Teams with a clearer common reform ambition and a more positive disposition towards the school-wide reform started more rapidly with the design and rethinking of their curriculum. Teams that started off with a more vague reform ambition needed sufficient clarity about the organizational conditions before starting to work on their concrete plans. Therefore, we may conclude that the design process of the TDTs is influenced by characteristics of the design team and in addition to the clarity of the initial reform ambition.

The TDTs' work process on the whole was neither explicitly planned nor structured. Irrespective of the context and support, TDTs' work seemed to advance from one meeting to the next without a clear overview of goals or structure. Teams required one of two kinds of triggers initiating a meeting. The first kind of trigger came from outside the team. This kind of trigger comes in the form of a coach or a school leader. When teams have an external coach, the fact that the coach makes an appointment to come and suggest discussion issues is enough to trigger a meeting. Alternatively, when the school or school-section leaders give the TDT a concrete assignment or summons a meeting, this too has the same effect. The second kind of trigger was the internal trigger. This kind of trigger comes from within the team and leads not only to holding a single meeting, but also to regular meetings. This trigger has two possible sources. In some teams, when teachers concluded a meeting with concrete decisions and appointments, this led to a following meeting based on these decisions. This was not a common practice for TDTs in this study. The other internal trigger is a sense of urgency felt by the teachers. This arose mostly at the end of the preparation year when teams needed to complete some form of teaching materials. This led to a burst of activities in TDTs. This urgency can lead to the team reverting to older and less ambitious plans than those they had developed. However, the more that team teachers own the development process the less need there is for an external trigger for the work of the teams.

TDTs had a clear pattern in which general design discussions were conducted together whereas construction of materials was an individual exercise done at home with little feedback between the team members. Joint work seemed limited to general issues and design statements. However, there are indications that cooperating on the concrete materials is most effective for arriving at curriculum materials that are more in line with the reform ambitions and represent a significant change from former practice. The findings by Voncken et al. (2007) also support the potential of cooperating on materials as an instrument for development of reform and the learning of teachers in the reform. They went even further and concluded that cooperation in teaching activities and undertaking new experiences together can be even more powerful.

Conducive Activities and Conditions

A first type of conducive activities share the characteristic of helping teachers to envision their possible future practice. As was apparent in the discussion about the development process, TDTs have a great need an operational image of the conditions in which their teaching would take place. This guides much of their work. Activities that contribute to this are conducive to the process by helping the teams move further, make design decisions, and come closer to creating a common curriculum. This relates to a variety of activities that also depend on the need of the specific TDT during a specific time. In this context, pilots or implementation of (part of) the materials have a positive effect on the teachers during the process. This gives teachers a concrete image of how students interact with the materials. A similar function can be achieved by taking field trips to schools implementing a similar reform or facing similar challenges. As already noted, the limitation of pilots is that they often seem to concentrate on the practicality of the plans and not on their effectiveness or validity, and their impact is also limited to those teachers that directly participate in the pilots. Possibly, setting a clear evaluative goal ahead of time and making it a team-wide endeavor can make pilots an even more effective instrument.

A second type of conducive activities is the discussion of concrete plans or products. These design attributes make the discussion concrete and focused. Abstract ideas are set on paper and that makes them tangible and accessible for discussion. Besides structuring the discussion, this broadens its scope, as teachers must consider all the implications of their decisions in the concrete. This finding is supported by Ametller, Leach and Scott (2007), who experimented with design attributes in the course of reform. According to them, these attributes make design explicit and also enable communication between teachers and designer.

A third type of conducive activities is explicit information on the school-wide reform ambitions. Specifically, schools or school section leaders that interact with the team in a direct manner during a meeting are seen as having significant potential for helping the team make progress. They can supply new information, help review the decisions already made at the school level, and hear ongoing questions.

A fourth type of conducive activities aim to tackle the apparent absence of informal interaction of teachers with members of other TDTs on issues related to the reform, which calls for some structured instruments. Two specific types of activities seem effective: presentations of teams' progress and concentrated schooling about relevant reform themes. First, the presentations of the teams' progress give other teams an overview of their development. It gives them insight into how far along other teams are, what problems they encountered, how they solved them, and what kinds of considerations other teams take into account in their work. This is information teams can use and do use for their own work. The presentations also have a relational function. Hearing how others struggle with and solve problems shows teachers and teams that they are in a sense 'not alone' in the process. This seems quite obvious in a school-wide process, but teams tend to see their problems as unique. Creating a bridging function can help teams see other developments. The second type of activity, study days, is aimed at providing clarity about the school-wide reform focus. Teachers often need additional information on different aspects. A crucial characteristic in making these study days effective and appreciated is their practical orientation. Such study days are only seen as relevant when they deliver concrete products that teams can easily apply in their development work, such as a framework for their work process and a framework for describing their curriculum materials. When study days fail to meet this criterion, they have little explicit effect on the development process.

Discussion

The study discussed in this chapter was originally carried out in 2004–2006. The concept of Teacher Design Teams was relatively new and this study was one of the first that discussed empirical characteristics of these teams. In this discussion we briefly discuss some new insights and research that is related to teacher design teams.

In contrast to many curriculum development models, the development process by the type of teacher design teams in this study does not begin by conducting analysis aiming to produce guidelines for design. Analysis activities, when executed, focus on organizational conditions regarding their future practice. In all teams the major design decisions, as reflected in their curricular products, are made very early in the process. Even when teams do not make conscious, 'formal', design decisions, the ideas discussed in the first meetings become the design, without their being critically examined for their merit. This confirms the assertion that design decisions tend to rapidly crystallize after the initial development phase (Romme & Endenburgs, 2006).

The teams had great difficulty managing vagueness of the curriculum reform. This seems similar to the instrumentality element of the practicality ethic of teachers (Doyle & Ponder, 1978). Teachers tend to focus on procedural elements of the reform at the cost of discussions on more substantive principles (cf. Jonker, Gijsen, März, & Voogt, 2017). This issue was also evident in the fact that teams regarded practicality of the plans and materials as the main quality criteria for their products.

A difference In the development process is apparent between the two types of teams (differing mainly in having or lacking a common initial ambition). Teams that start the process with little direction, and are 'held back' in exploring organizational conditions, get very little construction done during the preparation year. They combine the design and construction phases mostly at the end of the year and often recreate their former curriculum in the new school framework. Teams with clearer ambitions display somewhat more distinct design and construction phases. Construction mostly takes part at the end of the preparation year, under a great deal of pressure. The more structure there is, the more construction gets done.

TDTs are not inclined to initiate evaluation activities of any sort. Piloting of part of their curriculum materials is the only activity that somewhat resembles an evaluation. However, the guiding perspective of the pilots is that of practicality. Other issues of quality (such as validity and effectiveness) are hardly discussed, if at all. The lessons learned from the pilots are also limited to the participating teachers (often only one or two from the team). There is little transfer of the conclusions to teachers not directly involved in the pilot.

As the study presented limited itself to the preparation year, few significant implementation activities were documented. Findings from other research (Huizinga, 2014) do point to the potential catalytic effect of implementation. During implementation, teachers come across issues they did not foresee or activities that turn out other than expected. This can be a powerful instrument to elicit more evaluation activities. These evaluation activities need some support in order to make them constructive and transcend organizational issues. Stressing the importance of evaluation activities, Visscher and Witziers (2004) pleaded for concentrating teams' work on the evaluation of their practice, as this underlines the strong connection between the teaching process and the learning results. In a 'data-team approach' the analysis and compilation of data on the effectiveness of (parts of) the school are the starting point and central thrust of the team's work (Schildkamp & Kuiper, 2010). In conclusion, implementation, analysis and evaluation activities were not an inherent part of the development process of TDTs in this study. Design and construction were highly interrelated and more often executed as an integrated activity.

Findings of this study concerning the role fulfilled by the school management and the function of the TDTs lead to insights about the role that the relevant school leaders could and should fulfill. It seems then advisable that the school management apply a differentiated approach to teams, based on the teams' characteristics and the development that they show. Certainly when a flexible and developing reform strategy is applied with teams that have a vague reform ambition, a more proactive and involved role for the school management is called for. This conclusion is in line with both Nieveen and Handelzalts (2006) and Voncken et al. (2007).

References

Ametller, J., Leach, J., & Scott, P. (2007). Using perspectives on subject learning to inform the design of subject teaching: An example from science education. *Curriculum Journal, 18*(4), 479–492.

Black, P., & Atkin, J. M. (Eds.). (1996). *Changing the subject. Innovations in science, mathematics, and technology education*. London: Routledge.

Clandinin, D. J., & Connelly, F. M. (1992). Teacher as curriculum maker. In P. Jackson (Ed.), *Handbook of research in curriculum* (pp. 363–401). New York: Macmillan.

Doyle, W., & Ponder, G. A. (1978). Practicality ethic in teacher decision-making. *Interchange, 8*(3), 1–12.

Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Grossman, P., & Stodolsky, S. (1995). Content as context: The role of school subject in secondary school teaching. *Educational Researcher, 24*(8), 5–11.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record, 103*(6), 942–1012.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams*. Enschede: University of Twente. https://doi.org/10.3990/1.9789036528634

Hargreaves, A. (2003). *Teaching in the knowledge society. Education in the age of insecurity*. New York: Teachers College Press.

Hendriks, M. A. (2004). *Innoverende scholen voor voortgezet onderwijs: Thema's, trends en inspirerende voorbeelden* (Innovative high schools: Themes, trends and inspiring examples). Enschede, The Netherlands: University of Twente.

Henze-Rietveld, F. A. (2006). *Science teachers' knowledge development in the context of educational innovation* (Doctoral dissertation). Leiden, The Netherlands: University of Leiden.

Hopkins, D. (2001). *School improvement for real*. London: Routledge Falmer.

Hord, S. (2004). *Learning together, leading together. Changing schools through professional learning communities*. New York: Teachers College Press.

Huizinga, T. (2014). *Developing curriculum design expertise through Teacher Design Teams* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Jonker, H., Gijsen, M., März, V., & Voogt, J. (2017). Curriculumontwerp: Het ontwerpproces van een docentontwerpteam van de lerarenopleiding technisch beroepsonderwijs . [Curriculum design: the design process of a Teacher Design Team in technical vocational teacher education]. *Tijdschrift voor Lerarenopleiders, 38*(4), 71–84.

Lieberman, A., & Miller, J. (2004). *Teacher leadership*. San Francisco: Jossey-Bass.

Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.

Louis, K. S., & Marks, H. M. (1998). Does professional community affect the classroom? Teachers' work and student experience in restructuring schools. *American Journal of Education, 106*, 532–575.

McLaughlin, M. W., & Talbert, J. E. (2001). *Professional communities and the work of high school teaching*. Chicago: The University of Chicago Press.

McLaughlin, M. W., & Talbert, J. E. (2006). *Building school-based teacher learning communities. Professional strategies to improve student achievement*. New York: Teachers College Press.

Meirink, J. A., Meijer, P. C., & Verloop, N. (2007). A closer look at teachers' individual learning in collaborative settings. *Teachers and Teaching: Theory and Practice, 13*(2), 145–164.
Nieveen, N., & Handelzalts, A. (2006). *Concretisering kerndoelen onderbouw. Rapportage flankerend onderzoek* [Making attainment goals concrete. Research report]. University of Twente, Enschede, The Netherlands.
Onderbouw-VO. (2007). *Bewegen volgens plan. Monitor onderbouw 2006* [Reforming according to plan. Yearly evaluation 2006]. Zwolle, The Netherlands: Onderbouw-VO.
Onderbouw-VO. (2008). *Bewegen met beleid. Monitor onderbouw 2007* [Controlled change. Yearly evaluation 2007]. Zwolle, The Netherlands: Onderbouw-VO.
Romme, A. G. L., & Endenburg, G. (2006). Construction principles and design rules in the case of circular design. *Organization Science, 17*(2), 287.
Sackney, L., Mitchell, C., & Walker, K. (2005). *Building capacity for learning communities: A case study of fifteen successful schools.* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Québec, Canada.
Schildkamp, K., & Kuiper, W. (2010). Data informed curriculum reform: Which data, what purposes, and hindering and promoting factors. *Teaching and Teacher Education, 26*(3), 482–496.
Skilbeck, M. (1998). School based curriculum development. In A. Hargreaves, A. Lieberman, M. G. Fullan, & D. Hopkins (Eds.), *International handbook of educational change* (pp. 121–144). Dordrecht, The Netherlands: Kluwer Academic Publishers.
Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80–91.
Visscher, A. J., & Witziers, B. (2004). Subject departments as professional communities? *British Educational Research Journal, 30*(6), 785–800.
Voncken, E., Derriks, M., & Ledoux, G. (2007). *Een hele toer. Ervaringen van schoolleiders en docenten met de vernieuwing van de onderbouw vo* [Experiences of school leaders and teachers with the reform of the lower secondary education]. Amsterdam, The Netherlands: SCO-Kohnstamm instituut.
Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.
Zwart, R. C., Wubbels, T., Bergen, T. C. M., & Bolhuis, S. (2007). Experienced teacher learning within the context of reciprocal peer coaching. *Teachers and Teaching: Theory and Practice, 13*(2), 165–187.

Chapter 10
Implementation Activities in Design Teams: Opportunities to Demonstrate and Acquire Design Expertise

Tjark Huizinga, Nienke Nieveen, and Adam Handelzalts

Introduction

The implementation of curriculum reform at the school level is a complex process (Fullan, 2007). Too often, reforms are only partially implemented or are implemented in a way that does not represent the reform ideas (e.g., Fullan, 2007; Green, 1980; Stenhouse, 1975; Van den Akker, 2010). One explanation is that oftentimes the key stakeholder, the teacher, is not involved from the early stages of the design process (e.g., Borko, 2004; Darling-Hammond & McLaughlin, 1995; Fullan, 2007; Stenhouse, 1975). Consequently, teachers lack ownership for the curriculum reform or have a limited understanding of the goals and aim of the reform, because they might feel that they are only implementing the plans of others (Borko, 2004). However, having teachers take on the role of designer is considered to foster teachers' ownership and understanding of the reform (Fullan, 2007, McLaughlin & Talbert, 2006; Remillard, 1999, 2005; Stenhouse, 1975).

In the Netherlands, teachers are offered the opportunity to take on the role of designer, because teachers have been given 'curricular space' to shape their

T. Huizinga (✉)
Department of Innovative and Effective Education, Saxion University of Applied Sciences, Enschede, The Netherlands
e-mail: t.huizinga@saxion.nl

N. Nieveen
ELAN Department of Teacher Development, University of Twente, Enschede, The Netherlands
e-mail: n.m.nieveen@utwente.nl

A. Handelzalts
Teacher Education Department, Free University, Amsterdam, The Netherlands
e-mail: a.handelzalts@vu.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_10

school-specific curriculum (Kuiper, Van den Akker, Hooghoff, & Letschert, 2006; Nieveen & Kuiper, 2012; Nieveen, Van den Akker, & Resink, 2010). Various initiatives have provided teachers the opportunity to actively carry out the role of designer of curriculum materials (e.g., VO-Raad, 2014). Studies on these initiatives have reported positive findings on teachers' collaboration in curriculum development. For example, discussing the essence of the renewal and classroom implementation helps teachers to improve their understanding of the reform and fosters their ownership of the reform.

Collaborative design of curriculum materials has been identified as a promising way to foster the design of high quality curriculum materials, to enhance classroom implementation and to promote teachers' learning about design processes (Bakah, Voogt, & Pieters, 2012; Handelzalts, 2009; Hardré, Ge, & Thomas, 2006; Fullan, 2007). Collaboration, in what are called Teacher Design Teams [TDTs; teams of teachers who collaboratively (re)design part of their (shared) curriculum (cf. Handelzalts, 2009)], implies that teachers work together throughout the analysis, design, development, implementation and evaluation phases of a new curriculum (also referred to as the ADDIE model, Gustafson & Branch, 2002).

However, previous attempts suggested that teachers lacked certain knowledge and skills required to fulfil the role of designer (Bakah et al., 2012; Eggleston, 1980; Forbes, 2009; Handelzalts, 2009; Nieveen et al., 2010; Skilbeck, 1984). In order to play a significant role as a curriculum designer and to successfully implement the new curriculum materials in classroom practices, teachers need to have specific knowledge and skills; in particular, they need subject matter knowledge, pedagogical content knowledge and curriculum design expertise (Huizinga, 2009; Nieveen et al., 2010; Nieveen & Van der Hoeven, 2011; Schwab, 1973). The various categories of expertise required for designing high quality curricula have been comprehensively defined as 'design expertise' (Hardré, 2003; Hardré et al., 2006; Huizinga, 2009; Huizinga, Nieveen, Handelzalts, & Voogt, 2013; Nieveen & Van der Hoeven, 2011).

Previous studies have shown that teachers require support during the design process to enhance their design expertise and to tackle design challenges (e.g., Forbes, 2009; Handelzalts, 2009; Huizinga, Handelzalts, Nieveen, & Voogt, 2014; Kerr, 1981; Nieveen, Handelzalts, Van den Akker, & Homminga, 2005). Support can help teachers to reflect on their experiences, which can foster their design expertise (Hall & Hord, 2010; Linder, 2011; Nieveen et al., 2005). Classroom implementation and evaluation seem to offer especially strong opportunities for teacher learning when teachers reflect on their experiences (Guskey, 2000; Voogt et al., 2011). Despite the importance of implementing and evaluating a new curriculum, little is known about how teachers carry out these activities and what expertise they require (e.g., Handelzalts, 2009; Kerr, 1981).

In the current study, TDTs made up of foreign language teachers from secondary schools in the Netherlands were faced with the implementation of the Common European Framework of Reference for Languages [CEFR]. Implementing CEFR requires teachers to apply a skill-oriented approach to learning languages, which also implies that the role of grammar education changes. Furthermore, teachers are expected to guide their students in the learning process instead of offering instruction.

This study reports on the TDT's implementation and evaluation activities. These activities are assumed to provide opportunities to enhance teachers' curriculum design expertise. The question that guided this study was: *'What implementation and evaluation activities conducted during the design of a new curriculum provide opportunities for enhancing teachers' curriculum design expertise?'* This research question was further divided into three sub-questions: the first aimed at describing the implementation and evaluation activities teachers conducted during classroom implementation; the second question concerned the implementation and evaluation activities in the TDTs and the third focused on teachers' perceptions of the relevance and value of these implementation and evaluation activities for fostering curriculum design expertise.

Curriculum Implementation and Evaluation Expertise

Curriculum implementation is the process of using the new ideas and materials in classroom practice (Fullan, 2007; Tamir, 2004). Conducting implementation activities is expected to result in classroom practices that represent the original renewal ideas (Hall & Hord, 2010; Remillard, 2005). However, contextual limitations and personal beliefs, attitudes and expertise may affect to what extent the original renewal ideas are applied in practice by teachers (Remillard, 2005).

Enhancing ownership is essential, because without ownership a curriculum reform will not be implemented or will be implemented in a way that undermines the rationale and goal of the renewal. Therefore, teachers who carry out the role of designers need to know the importance of and how to foster ownership (Kessels & Plomp, 1999). They need to identify relevant stakeholders, such as the school's management and colleague teachers outside the TDT, and to involve them in the design processes from an early stage (Kessels & Plomp, 1999). By involving stakeholders, the new curriculum can be aligned with stakeholders' wishes, needs and expectations. Moreover, collaboratively planning the classroom usage of the new curriculum fosters teacher ownership (Penuel, Fishman, Yamaguchi, & Gallagher, 2007), especially when the teacher role, teacher-student interaction and practical issues are discussed. Additionally, identifying the differences between teachers' current practice and the new curriculum fosters teachers' understanding of the new curriculum.

Managing implementation processes should not start only once the curriculum materials have been designed. Successful curriculum reform requires that the implementation of the curriculum reform is already being managed from the start of the curriculum design process. Carefully planning *who* will implement *what* and *when* helps to guide the design process. The plan describes the goal and scope of the implementation process, and when to involve experts and stakeholders (Richey, Fields, & Foxon, 2001). TDTs need to monitor the progress of the implementation to identify to what extent the new curriculum is being implemented in practice.

Reflecting on the teachers' experiences with the new curriculum may result in revising or adjusting the plan.

Sharing experiences throughout the process fosters classroom implementation (Handelzalts, 2009). Piloting newly designed curricula and reflecting on their experiences enhances teachers' understanding of the new curriculum, especially when experiences are shared with colleagues (Hall & Hord, 2010). Providing curricular programs and exemplary materials helps to improve teachers' understanding of the new curriculum. Exemplary materials that represent the reform ideas shed light on how the reform can be operationalised in practice (Van den Akker & Voogt, 1994) and might even be directly usable in practice. Finally, guiding teachers to develop a shared understanding of the renewal fosters classroom implementation. Guidance can be offered by demonstrating the new curriculum (e.g., by offering an exemplary lesson or video examples), and through collegial preparation, implementation and reflection on the use of the new curriculum (Hall & Hord, 2010).

Evaluation refers to the process of determining the worth and merit of a curriculum (Scriven, 1991). Formative evaluations help to identify the aspects that require improvement. Summative evaluations aim to determine the effectiveness of the new curriculum, for example, in terms of student learning (Scriven, 1991). Evaluations can address the product (curriculum) or the design process. Product evaluations identify the consistency, relevance, practicality and effectiveness of the curriculum materials (Nieveen, 2009). Process evaluations address the decisions made, the implementation process and the collaboration within the team.

For planning, structuring and carrying out formative and summative evaluations, teachers must be able to formulate evaluation goals, develop instruments, collect data, analyse the data and interpret the results (Cochran-Smith & Lytle, 2009; Huizinga, 2009; Schildkamp, Poortman, & Handelzalts, 2015). It is desirable for teachers to plan and conduct formative and summative evaluations as part of the design process in order to guarantee the quality of the new curriculum. To conduct evaluations, teachers as designers need instruments, either already available or newly developed (Richey et al., 2001). The focus of the evaluation (formative-summative, process-product, phase in the design process) influences the kind of instruments needed (Nieveen, 2009). Teachers as designers need to be able to link the instruments to the evaluation goals.

Quality criteria and activities for evaluating products depend on the stage of the design process. Therefore, teacher as designers are expected to have an understanding of how to assess the consistency, relevance, practicality and effectiveness of the designed curriculum (Nieveen, 2009; Richey et al., 2001). They are expected to assess each quality-related aspect and apply various evaluation methods, since this offers additional insights into the aspects that require improvement. However, previous studies have shown that teachers as designers often do not conduct systematic evaluation activities (Handelzalts, 2009; Kerr, 1981).

Analysing outcomes and improving curriculum. Teacher designers identify the elements of the new curriculum that require improvement. The evaluation data that are gathered need to be analysed and interpreted (Schildkamp et al., 2015). After analysing the outcomes, the teacher designers determine how to improve the curriculum and who will make the changes (Richey et al., 2001).

Research Design

A qualitative case study method was applied (Yin, 2003). Within each case (a TDT), teachers (members of the TDT) used the CEFR-based curriculum their TDT designed in the first stage of the project in their classrooms. All activities conducted by the TDTs and its members to prepare and use the new CEFR-proof curriculum (i.e. language tasks [authentic tasks in which students need to apply the language], assessment rubrics and school-specific adaptations of CEFR regarding teacher role and student activities) in practice are addressed as implementation activities. Evaluation activities relate to activities the TDT and its members conducted to determine the worth and merit of the language tasks and assessments rubrics.

Case Selection

TDTs were selected from the CEFR-project who (1) integrated CEFR in their foreign language curriculum, (2) created language tasks (and assessment rubrics) during the analysis and design stage, and (3) planned to use the new curriculum in their classrooms. Based on these criteria, three cases (out of 15) were selected for this study: Plato, Thales and Othello. They varied in the number of teachers involved in the TDT (5–16 teachers). All participating TDTs received tailored support from different facilitators, who were employed at the Netherlands Institute for Curriculum Development. The facilitators were both curriculum developers and former language teachers. The facilitators were familiar with CEFR and experienced in supporting TDTs. Othello's TDT was part of a greater community of schools and received guidance from two facilitators.

Data Collection

Five instruments and one artefact were used. All instruments were discussed in the research team to warrant content validity (Yin, 2003).

Storyline method. The storyline method helps teachers reflect on processes. Based on a guiding question, the teachers draw a line in a coordinate system. The x-axis represents the time (in months) and the y-axis represents the teachers' experiences, on a five-point scale ranging from very negative (1) to very positive (5). Teachers individually drew a storyline and afterwards each teacher individually clarified (changes in) the line (Beijaard, Van Driel, & Verloop, 1999; Handelzalts, 2009). The guiding questions in this study were: "*How did you experience the design process as conducted within the TDT?*" and "*How did you experience the classroom implementation of the CEFR-proof curriculum?"* While introducing the storyline method, the researcher emphasised reflecting on implementation and evaluation activities. The teachers received an overview of the implementation and evaluation activities that had been conducted. The storyline method was expanded with a semi-structured group interview to identify support offered to the TDTs (Huizinga, Handelzalts, Nieveen, & Voogt, 2015). Transcriptions and summaries were made and summaries were sent to the teachers for member checking (Merriam, 1988).

Observation checklist TDT meetings. The observation checklist of Huizinga et al. (2015) was adapted to identify TDTs' implementation and evaluation activities. The checklist addressed the activities conducted, teachers' reactions during these activities, teachers' questions raised during the meetings (and facilitators' response if applicable), concerns articulated that were related to the activities, and the contextual setting in which the meeting was organised.

Semi-structured interview facilitator. A semi-structured interview with the facilitator was administered to identify the characteristics of the support offered to the TDTs during the implementation and evaluation phases. These insights were used to identify and triangulate the TDTs' implementation and evaluation activities.

Observation checklist classroom observation. An observation checklist was developed, which included the lesson activities, teacher's role during the lesson activities, student-teacher interaction and the context in which the lesson was conducted.

Semi-structured interview teachers. The interview addressed teachers' experiences of the observed lesson, to what extent the observed lesson could be compared with other CEFR lessons and the (need for) support to carry out implementation and evaluation activities.

Language task. The language tasks in the observed lessons were analysed to identify the intended curriculum (e.g., CEFR proficiency level, learning activities). These insights were compared with the classroom observations to identify when changes were made by the teachers while using the language tasks in practice.

The data collected data used to (1) re-construct the TDTs' implementation and evaluation activities, (2) determine teachers' experiences of the TDTs' implementation and evaluation activities, and (3) determine the implementation and evaluation activities in teachers' own classrooms, and determine teachers' experiences with implementation and evaluation activities in their own classroom.

Data Analysis

All qualitative data were analysed using 'a priori' coding (Strauss & Corbin, 1998). This data analysis technique prescribes that a codebook is based on the theoretical framework. While analysing, the codes are linked to (parts of) the data. Inductive coding was applied to find additional themes related to the implementation and evaluation process and teachers' experiences.

The first author took the lead in the coding process. Quotes were selected and codes were assigned. First, quotes were related to TDT or classroom activities and the researcher identified whether the quote illustrated teachers' experiences with the activities (level-1 code). For example, the quote "*we have worked on it [implementation] [during the support meeting with all foreign language teachers]. Positive memories about it.*" was assigned the code "TDT-Experience-Implementation". Second, the specific characteristic of the activity was identified (level-2 code).

Table 10.1 Section of the final codebook

Level 1 code	Description of the code	Example quote [*data source*]
TDT-implementation	Implementation activity conducted by TDT (e.g., preparation for using materials in practice)	'Then [during schoolwide support day], […] I experienced that as positive, because our colleagues outside the TDT responded enthusiastically […] We made some agreements [about using CEFR]" [*storyline reflection]*
TDT-evaluation	Evaluation activity conducted by TDT (e.g., reflecting on use in classroom)	"I used existing [evaluation] formats that we have developed for a course about curriculum design. I changed these formats completely to align them to the vision of the school and discussed it with the teachers. The teachers tested the instrument in practice" [*interview facilitator*]
TDT-experience-implementation	TDT member experience of conducted activity related to using CEFR in the classroom	"If you look at all our meetings, the overall line is clear. Each individual meeting was useful, especially when you receive examples of how to do it in practice" [*storyline reflection]*
TDT-experience-evaluation	TDT member experience of activity conducted related to evaluating the use of CEFR in the classroom	'I was sitting next to my colleague […], I wrote a reflection on the language tasks, summing up 'check this, look at that'. That's the way we provide feedback, just-in-time or if you experience difficulties' [*storyline reflection]*
Classroom-implementation	Teachers' individual use of CEFR in the classroom	'The teacher starts the lesson in French. She explains that if students have difficulties in understanding the teachers, she [teacher] will provide the translation. [*classroom observation*]
Classroom-evaluation	Evaluation activities conducted by individual teachers	'During my own evaluation, I ask myself the question 'what went wrong' and 'what did not go as I expected'. I discuss this with my students, because they might experience it defiantly.' [*Interview teacher*]

(continued)

Table 10.1 (continued)

Level 1 code	Description of the code	Example quote [*data source*]
Classroom-experience-implementation	Teachers' personal experience of using CEFR in his/her own classroom	'The overall experience of today's lessons also depends on the students' final products. There were a lot of practical questions, […], which might be the case because the language tasks were too textual for these students.' [*Interview teacher*]
Classroom-experience-evaluation	Teachers' personal experience of carrying out evaluations related to the use CEFR in his/her own classroom	'At the end of the lesson I've asked for feedback, normally I don't ask for written feedback, but it requires students to reflect on the task they carried out.' [*Interview teacher*]
Level 2 code [example for 'TDT-implementation']	Description of the code	Example quote [data source]
Enhancing ownership	Conducting activities to enhance ownership (e.g., collaborative preparation for classroom use, involving stakeholders in design)	'For English, 16 teachers were at the meeting. The TDT started with a discussion about the examination program. They discussed to what extent all programs need to be similar. [*TDT observation*]
Managing implementation process	Conducting activities required for process management (e.g., developing plan, monitoring progress)	From one of the locations, the expectation was that more support would be provided from the school's management and that more schoolwide support meetings were organised. The teachers argued that using CEFR in practice requires additional professional development activities. [*TDT observation]*
Sharing experiences	Conducting activities in which experiences with the new curriculum are shared (e.g.,the new curriculum, providing video examples)	The French teacher explains that the experienced resistance was also related to the fact that students are not used to working with language tasks. In the last year, she used several language tasks. Her students appreciate them more than regular lessons. [group discussion during *TDT observation*]

The sample quote above, for example, was assigned the level-2 code "*enhancing ownership"*. Throughout the coding process, the application of codes was discussed in the research team until consensus was achieved. In Table 10.1 a section of the final codebook is provided, in which the codes, and a description and example for both the level-1 codes and the level-2 codes are included.

Main Findings

This study was undertaken to identify *what* implementation and evaluation activities conducted by TDTs provide opportunities to enhance teachers' curriculum design expertise. Therefore, implementation and evaluation activities that were conducted were identified and teachers reflected on their experiences with these activities, as initiated during classroom implementation and by TDTs. These insights illustrate which implementation and evaluation activities teachers valued and found relevant for their process.

Teachers' Classroom Implementation and Evaluation Activities

The activities carried out in and by the TDTs were intended to prepare the teachers to implement the new curriculum in the classroom and to evaluate the lessons. Classroom observations revealed great variation in classroom implementation across teachers within and between the different TDTs. The skill-oriented approach for learning languages required students to actively use the foreign language. The language tasks that were developed partly prescribed to what extent the foreign language had to be spoken by teachers and students, which was the case for Plato and Othello. The language village task, which was used by Othello, required both teachers and students to use the foreign language, since the conversations between them were the core of the task. Integrating the skill-oriented approach also required teachers to fulfil the role of coach. The results illustrated that coaching differed across teachers both within and between cases. In Thales, teachers offered a detailed introduction in which the entire language task was clarified for the students. In contrast, in Plato and Othello, teachers coached their learners by providing just-in-time guidance required to complete the tasks.

Teachers' reflections revealed that classroom implementation and evaluation were affected by their understanding of CEFR, the new pedagogy and especially the teacher role. Plato's and Othello's teachers had various questions about their role and wondered whether they had offered too much guidance. Although various discussions within the TDTs had addressed the pedagogy and exemplary materials and videos were offered (cf. Ball & Cohen, 1996), the results of this study suggest that only discussing and observing a new pedagogical approach is too limited to acquire the required expertise (cf. Voogt et al., 2011). Therefore, it seems essential that additional opportunities in which teachers can apply the new pedagogical approach and use the new curriculum are necessary to improve their pedagogical skills and develop confidence in the new approach.

Teachers in all three TDTs discussed the language tasks with their fellow colleagues during and outside TDT meetings. However, collegial feedback appeared not to be enough to develop high quality language tasks, emphasizing the need for piloting the language tasks in teaching practice (cf. Handelzalts, 2009). Furthermore, the results illustrated that teachers hardly involved students in their evaluations, suggesting that teachers need to learn *how* to involve their learners with the aim of improving the language tasks.

TDTs' Implementation and Evaluation Activities and Corresponding Experiences

Table 10.2 provides the results of the cross-case analysis of the three TDTS. Each TDT organised its own implementation process, implying that the type and intensity of the activities varied across the three TDTs. All TDTs conducted activities in which experiences were shared, for example, though exemplary materials or video examples. *How* experiences were shared depended on the TDT and the context in which the TDT was operating. Consequently, the opportunities for conducting and experiencing specific activities differed. In Plato, not all foreign language teachers were part of the TDT. Therefore, Plato's TDT had to conduct additional activities to enhance ownership, for example, by discussing the new pedagogy with their colleagues and providing exemplary materials. In Thales and Othello teachers shared experiences during collegial meetings by illustrating how they had used a particular language task in practice. Teachers' reflections revealed that they acquired new ideas on *how* to use the new curriculum, which fostered its implementation (cf. Anto, 2013; Huizinga et al., 2015). However, teachers also indicated struggling with translating the curriculum reform to their classroom practices and they had concerns about the pedagogy. In Thales and Othello all foreign language teachers were involved in the TDT; therefore, managing and structuring the implementation

Table 10.2 TDT's implementation and evaluation expertise

Characteristics	Plato	Thales	Othello
Duration of process	16 months	9 months	9 months
Implementation knowledge and skills			
Enhancing ownership	+	+	+
Managing implementation processes	−	+/−	+/−
Sharing experiences	+	+	+
Evaluation knowledge and skills			
Planning, structuring and carrying out evaluations	+/− planning +/− structuring + carrying out	−	+ planning +/− structuring + carrying out
Quality criteria and activities for evaluating products	+/−	−	+/−
Analysing outcomes and improving curriculum	+	−	+

Note: + knowledge and skills sufficient, various activities carried out by TDT; +/− knowledge and skills limited, some activities carried out by TDT; − knowledge and skills insufficient, no activities carried out by TDT process needed explicit attention. This explicit attention also seems to provide opportunities to enhance curriculum design expertise.

Each TDT also organised their own evaluation activities, which resulted in unplanned and unstructured evaluations in Plato and Othello. These evaluations provided the TDTs with insights into the practical quality of the curriculum: alignment with students' prior knowledge and internal consistency of the design language. In Thales no evaluations were conducted, despite the fact that they received external support regarding the role of evaluations and how to conduct them. The reason might be that the support concerning evaluation was not offered when the teachers needed it (cf. Handelzalts, 2009).

Based on the implementation activities carried out and the teachers' reflections, it seemed that the expertise within TDTs was adequate to foster the implementation process. Furthermore, evaluation activities closely related to teachers' classroom practice, such as piloting assessment rubrics and language tasks, were especially valued by teachers (cf. Handelzalts, 2009; Huizinga et al., 2014, 2015). Teachers felt that collegial feedback and presenting their TDT's progress to other TDTs made them aware of what they had achieved (cf. Hall & Hord, 2010), but teachers did not indicate that that this fostered the implementation and evaluation process. Based on the evaluation activities carried out, it seems that teachers' expertise in this domain was limited (cf. Handelzalts, 2009; Kerr, 1981).

Conclusion and Discussion

Teachers are increasingly involved in the design of a curriculum reform (Forbes, 2009; Handelzalts, 2009; Law & Nieveen, 2010; Lohuis, Huizinga, 't Mannetje, & Gellevij, 2016). Although most teachers have experience in adapting existing materials to specific needs (e.g., Remillard, 1999, 2005), they have less experience in designing curriculum reform at the subject level. Despite this lack of experience, this study showed that teachers as designers initiate various implementation strategies, but rarely conduct evaluation activities.

During classroom implementation teachers used the developed curriculum materials in practice, but did little evaluation of the lessons and the materials used. Furthermore, the teachers in the TDTs experienced how important it is to enhance their colleagues' ownership for the materials. They initiated various implementation activities to develop their colleagues' ownership. They collaboratively prepared for classroom implementation, shared experiences of their own classroom implementation with colleagues outside the TDT, offered exemplary materials and discussed video-recordings of lessons. The observations revealed that the TDTs in this study conducted few evaluation activities. The evaluations they did perform were rather unprepared, unstructured and emphasised the practical quality of the new curriculum materials, but focused less on the students' learning. This led to the conclusion that teachers in TDTs need additional support to conduct evaluation activities.

Teachers as designers must deal with design challenges when they design curriculum materials in teams. These challenges not only consist of the decisions that have to be made about the materials themselves, but also concern how to organize the implementation process. In order to deal with these challenges, teachers need to find, select and apply relevant strategies to enhance the design and implementation process. However, most teachers have limited prior experience in curriculum design and struggle with finding the relevant strategies to overcome the challenges experienced. The results of this study underline that teacher involvement in the design of concrete curriculum materials through TDTs provides teachers with various opportunities to learn about curriculum design and the intended curriculum reform. As previous studies have illustrated, in TDTs teachers learn to make decisions about the curriculum materials and the curriculum design process (Handelzalts, 2009; Huizinga et al., 2015). This study also underlined that teachers experience the influence of their choices on classroom implementation. The potential of carrying out design activities for developing teachers' curriculum design expertise is not yet fully utilised by TDTs, because some design activities, such as evaluation, are rarely conducted by TDTs.

The results of this study further illustrate that working in TDTs offers opportunities to practice and acquire implementation and evaluation skills (cf. Ben-Peretz, 1990; Voogt et al., 2011). The specific activities conducted by the teams of teachers provide opportunities for teacher learning, both about the reform framework and about the implementation and evaluation stages of curriculum design (cf. Penuel et al. 2007; Voogt et al., 2011). The findings underpin the importance of reflecting on the activities conducted as well as sharing these insights with colleagues (Hall & Hord, 2010; Voogt et al., 2011). Explicit attention for evaluation expertise is needed, since teachers seem to develop this little while working in TDTs (cf. Handelzalts, 2009; Hoogveld, 2003; Kerr, 1981).

This study shed light on the implementation and evaluation activities carried out by teachers in TDTs and during classroom enactment of the new materials. First, the study shows that the members of the TDT need to understand the essence of ownership and how to foster it (cf. Kessels & Plomp, 1999), especially when not all their colleagues are involved in the TDT. TDTs can achieve this by involving their colleagues at specific points during the design process, as was the case in Plato, where colleagues outside the TDT were involved during support meetings. Second, in contrast to Richey et al. (2001), managing the implementation process is not necessarily an expert-designer skill, as this study found that the TDT's coordinators had basic planning and monitoring skills. Third, TDT activities that were closely related to (changing) classroom practice were valued by teachers and seemed to offer opportunities for learning. Previous studies have suggested that supporting teachers in reflecting on their experiences helps to deepen their understanding of the activities conducted (e.g., Anto, 2013; Huizinga et al., 2015). Finally, classroom implementation helped to deepen teachers' understanding of the new curriculum, especially when they shared experiences with fellow teachers and had to explain what they did during classroom implementation (cf. Hall & Hord, 2010).

Kirkpatrick (1979) argued that positive experiences and beliefs illustrate which activities are necessary for teacher learning. In this study, the implementation and evaluation activities that were conducted together with teachers' reflections on these activities were used to identify what opportunities TDTs provide for enhancing curriculum design expertise. Therefore, the storyline method was applied to let teachers reflect on their process and the decisions made to conduct specific activities. It was assumed that when teachers did not conduct *and* did not indicate why certain activities were not conducted, they lacked the design expertise for implementation and evaluation. However, teachers might have that expertise, but did not reflect or demonstrate it during the process.

The knowledge and skills needed for implementation and evaluation were derived from overviews developed to describe the expertise of instructional and curriculum designers. Although in previous studies these knowledge and skills were translated to fit teachers and the design tasks they face (Huizinga, 2009; Huizinga et al., 2014; Nieveen & Van der Hoeven, 2011), the results of this study suggest that some of the identified knowledge and skills for implementation and evaluation might not be developed through participation in TDTs. Teachers might not develop the expertise to plan and structure evaluations while working in TDTs and, therefore, need just-in-time support to acquire this expertise (cf. Handelzalts, 2009). This study also illustrated that support which is not offered just-in-time will not result in acquiring the necessary expertise, as was the case in Thales.

The results of this study showed that without specific just-in-time support, TDTs initialise various activities to foster the implementation, such as enhancing ownership for the new curriculum (e.g., through involving colleagues in design activities) and sharing experience with teachers within and outside the TDT (e.g., by offering exemplary materials and videos). However, without support TDTs rarely plan and conduct (structured) evaluation to assess the quality of the designed curriculum (cf. Handelzalts, 2009; Kerr, 1981). The only evaluation activities by TDTs focused on the practical aspects of the curriculum (e.g., feasible within the given time, do the students understand and learn from the language task). They did not evaluate how the materials were used in the classroom or the effects of the materials on students. In some cases, students were involved in the evaluation activities. Since most evaluation activities were based on teachers' (personal) experiences to assess the quality, it seems that teachers in TDTs need additional expertise to conduct a wider variety of evaluation activities to assess the quality of the new curriculum. This additional expertise can be fostered by providing just-in-time support aligned with teachers' prior knowledge and experiences.

References

Anto, A. G. (2013). *Collaborative teacher professional development in Ethiopian higher education: The case of communicative language teaching* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012). Advancing perspectives of sustainability and large-scale implementation of design teams in Ghana's polytechnics: Issues and opportunities. *International Journal of Educational Development, 32*, 787–796.

Ball, D., & Cohen, D. (1996). Reform by the book: What is – or might be – the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6–8. 14.

Beijaard, D., Van Driel, J., & Verloop, N. (1999). Evaluation of story-line methodology in research on teachers' practical knowledge. *Studies in Educational Evaluation, 25*, 47–62.

Ben-Peretz, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. New York: State University of New York Press.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15.

Cochran-Smith, M., & Lytle, S. L. (2009). *Inquiry as stance: Practitioner research for the next generation*. New York: Teacher College Press.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan, 76*(8), 597–604.

Eggleston, J. (1980). *School-based curriculum development in Britain: A collection of case studies*. London: Routledge & Kegan Paul.

Forbes, C. T. (2009). *Preservice elementary teachers' development of pedagogical design capacity for inquiry: An activity-theoretical perspective* (Doctoral dissertation). Ann Arbor, MI: University of Michigan.

Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Green, E. L. (1980). The independent learning in science model of school-based curriculum development. In J. Eggleston (Ed.), *School-based curriculum development in Britain: A collection of case studies* (pp. 14–40). London: Routledge & Kegan Paul.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Gustafson, K. L., & Branch, R. M. (2002). *Survey of instructional development models* (4th ed.). Syracuse, NY: Syracuse University.

Hall, G. E., & Hord, S. M. (2010). *Implementing change: Patterns, principles, and potholes* (3rd ed.). New York: Pearson College Division.

Handelzalts, A. (2009). *Collaborative curriculum design in teacher design teams* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Hardré, P. L. (2003). The effects of instructional training on university teaching assistants. *Performance Improvement Quarterly, 16*(4), 23–39.

Hardré, P. L., Ge, X., & Thomas, M. K. (2006). An investigation of development toward instructional design expertise. *Performance Improvement Quarterly, 19*(4), 63–90.

Hoogveld, A. W. M. (2003). *The teacher as designer of competency-based education* (Doctoral dissertation). Heerlen, The Netherlands: Open University.

Huizinga, T. (2009). *Op weg naar een instrument voor het meten van docentcompetenties voor het ontwikkelen van curricula [Towards an instrument to measure teachers' competencies for the development of curricula; Master's thesis]*. Enschede, The Netherlands: University of Twente.

Huizinga, T., Nieveen, N., Handelzalts, A., & Voogt, J. M. (2013). Ondersteuning op curriculumontwikkelexpertise van docentontwikkelteams [Support to teacher design teams to foster teachers' curriculum design expertise]. *Pedagogische Studiën, 90*(3), 4–20.

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2014). Teacher involvement in curriculum design: Need for support to enhance teachers' design expertise. *Journal of Curriculum Studies, 46*(1), 33–57.

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2015). Fostering teachers' design expertise in teacher design teams: Conducive design and support activities. *The Curriculum Journal, 26*(1), 137–163.

Kerr, S. T. (1981). How teachers design their materials: Implications for instructional design. *Instructional Science, 10*, 363–378.

Kessels, J. W. M., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709.

Kirkpatrick, D. L. (1979). Techniques for evaluating training programs. *Training and Development Journal.* June, 178–192.

Kuiper, W., Van den Akker, J., Hooghoff, H., & Letschert, J. (2006). Curriculum policy and school practice in a European comparative perspective. In J. Letschert (Ed.), *Curriculum development re-invented* (Proceedings of the invitational conference on the occasion of the 30 years SLO 1975-2005. Leiden, the Netherlands, 7-9 December 2005) (pp. 56–77). Enschede, The Netherlands: SLO.

Law, E. H., & Nieveen, N. (2010). *Schools as curriculum agencies: Asian and European perspectives on school-based curriculum development*. Rotterdam: Sense Publishers.

Linder, S. M. (2011). The facilitator's role in elementary mathematics professional development. *Mathematics Teacher Education and Development, 13*(2), 44–66.

Lohuis, A. H., Huizinga, T., 't Mannetje, J. E. M. M., Gellevij, M. R. M. (2016). *Improving support to Teacher Design Teams to foster teachers' design expertise and blended learning expertise*. Paper presented during the EAPRIL conference, Porto, Portugal.

McLaughlin, M. W., & Talbert, J. E. (2006). *Building school-based teacher learning communities. Professional strategies to improve student achievement*. New York: Teachers College Press.

Merriam, S. B. (1988). *Case study research in education*. San Francisco: Jossey-Bass.

Nieveen, N. (2009). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 89–102). Enschede, The Netherlands: SLO.

Nieveen, N., & Kuiper, W. (2012). Balancing curriculum freedom and regulation in the Netherlands. *European Educational Research Journal, 11*(3), 357–368.

Nieveen, N., & Van der Hoeven, M. (2011). Building the curricular capacity of teachers: Insights from the Netherlands. In P. Picard & L. Ria (Eds.), *Beginning teachers: A challenge for educational systems – CIDREE yearbook 2011* (pp. 49–64). Lyon, France: ENS de Lyon, Institut français de l'Éducation.

Nieveen, N., Handelzalts, A., Van den Akker, J. J. H., & Homminga, S. (2005). *Teacher design teams: A scenario for school-based curriculum innovation*. Paper presented at the ECER, Dublin, Ireland.

Nieveen, N., Van den Akker, J. J. H., & Resink, F. (2010). Framing and supporting school-based curriculum development in the Netherlands. In E. H. Law & N. Nieveen (Eds.), *Schools as curriculum agencies: Asian and European perspectives on school-based curriculum development* (pp. 273–283). Rotterdam, The Netherlands: Sense Publishers.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry, 29*, 315–342.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211–246.

Richey, R. C., Fields, D. C., & Foxon, M. (2001). *Instructional design competences: The standards* (3rd ed.). Syracuse, NY: Clearinghouse on Information & Technology Syracuse University.

Schildkamp, K., Poortman, C. L., & Handelzalts, A. (2015). Data teams for school improvement. *School Effectiveness and School Improvement, 27*(2), 228–254.

Schwab, J. J. (1973). The practical 3: Translation into curriculum. *School Review, 81*(4), 501–522.

Scriven, M. (1991). *Evaluation thesaurus* (4th ed.). Newbury Park, CA: Sage.

Skilbeck, M. (1984). *School-based curriculum development*. London: Harper & Row.
Stenhouse, L. (1975). *An introduction to curriculum research and development*. London: Heinemann Educational Books.
Strauss, A., & Corbin, J. (1998). *Basics of qualitative research techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.
Tamir, P. (2004). Curriculum implementation revisited. *Journal of Curriculum Studies, 36*(3), 281–294.
Van den Akker, J. J. H. (2010). Building bridges: How research may improve curriculum policies and classroom practices. In S. Stoney (Ed.), *Beyond Lisbon 2010: Perspectives from research and development for education policy in Europe* (CIDREE Yearbook 2010) (pp. 175–195). Slough, UK: NFER.
Van den Akker, J. J. H., & Voogt, J. (1994). The use of innovation and practice profiles in the evaluation of curriculum implementation. *Studies in Educational Evaluation, 20*, 503–512.
Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teacher and Teaching Education, 27*(8), 1235–1244.
VO-Raad. (2014). *Klaar voor de toekomst! Samen werken aan onderwijskwaliteit. Sector akkoord VO 2014–2017 [Ready for the future! Collaborating on the quality of education. Sectoral agreement secondary education 2014–2017].* Den Haag, The Netherlands: VO-Raad.
Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Chapter 11
Human and Blended Support to Assist Learning About ICT Integration in (Pre-service) Teacher Design Teams

Ghaida Alayyar and Petra Fisser

Introduction

Jimoyiannis (2010) argued that true learning in the twenty-first century requires students to be able to use ICT, not only for enhancing the memorization of facts, but also for solving problems in real world settings. This means that there is an increased and urgent need to develop *teachers* who can integrate ICT in their teaching practice. Teacher preparation programs are providing their students (i.e., pre-service teachers) with a variety of ICT tools and opportunities to learn and practice ICT-related skills; however, many studies have reported that pre-service teachers are unable to use or integrate ICT in their own teaching practices (e.g., Chen, 2008; Fishman & Davis, 2006; Palak & Walls, 2009; Tondeur, Roblin, van Braak, Fisser, & Voogt, 2013; Zhao, Pugh, & Sheldon, 2002), especially when the ICT courses or training programs focus mainly on the acquisition of basic ICT skills. Several studies have shown that the acquisition of basic ICT skills is not sufficient to develop the ability to teach effectively with ICT (Doering, Veletsianos, Scharber, & Miller, 2009; Jimoyiannis, 2008; Tondeur et al., 2016; Wetzel, Wilhelm, & Williams, 2004; Zhao & Bryant, 2006). For teachers to be able to integrate ICT in their teaching they need an intensive course on the pedagogical use of ICT for a certain subject (Baylor & Ritchie, 2002; Becker, 2001). Kereluik, Mishra, and Koehler (2010) argued that "teachers need to know how to integrate technologies into their teaching in ways that are flexible, tolerate ambiguity, and connect to deep subject matter learning" (p. 3892). A possible explanation for teachers' lack of ability to use the potential of

G. Alayyar (✉)
College of Basic Education – The Public Authority for Applied Education and Training, Adailiyah, Kuwait
e-mail: g.alayyar@gmail.com

P. Fisser
National Institute for Curriculum Development, Enschede, The Netherlands
e-mail: p.fisser@slo.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_11

ICT to solve pedagogical problems is that teachers experience difficulty in understanding the complex relationships between ICT, pedagogy and content, because these three domains are often taught in isolation in teacher education programs (Koehler, Mishra, Hershey, & Peruski, 2004; Mishra & Koehler, 2006; Zhao, 2003).

Background

ICT Integration in Education

ICT integration implies that teachers are able to use ICT to introduce, reinforce, extend, enrich, and assess students' mastery of new concepts in a natural, flawless act of selecting the right tool for the learning task (Kelly, 2002). With powerful tools accessible for both teachers and learners, teachers need to realize that their role is changing, and that they can no longer be the source of all information and direct all learning. Teachers must become facilitators of learning who will foster self-motivated, self-regulated learning in their students.

Churchill (2009) argued that ICT adds a new dimension to teaching effectiveness by enabling teachers to do things that might not be possible within the traditional classroom. Using blogs to publish students' own writing, discuss topics of interest, and engage in peer review and collaboration is an example that provides a new spectrum of teacher-student and student-student interactions beyond the classroom or school environment. Godfrey (as cited in Sang, Valcke, van Braak, & Tondeur, 2010) summarized the potential of ICT in education as follows: "ICT presents a rich learning environment, allowing the learners to adopt multiple perspectives on complex phenomena, to foster flexible knowledge construction in complex learning domains, and to cater for individual differences (p. 103)". This implies the shift of the teacher role from being a lecturer to being a facilitator, and this also signifies that the learning environment will become more student-centred instead of teacher-centred. ICT has fundamentally changed many aspects of educators' lives. Teachers and teacher-educators are no longer focusing on the decision whether to adopt ICT in education or not, but rather on the implementation and integration process (e.g., Angeli & Valanides, 2009). In order to be successful in this, it is important that teachers have sufficient ICT competencies and are aware of the pedagogical use of ICT in education. Besides ICT competencies, research has found that attitude toward computers and computer self-efficacy are also predictors of ICT use among teachers (Christensen & Knezek, 1996; Vannatta & Fordham, 2004).

Harris, Mishra, and Koehler (2009) argued that ICT integration approaches that "did not reflect disciplinary knowledge differences, the corresponding process for developing such knowledge, and the critical role of context ultimately are of limited utility and significance, as they ignore the full complexity of the dynamic realities of teaching effectively with technology (p. 395)". This implies that teachers should also be aware that introducing new ICT tools in teaching not only changes the use of tools in teaching but also what we teach and how we teach, which is an important and often overlooked aspect of many ICT integration interventions.

Technological Pedagogical Content Knowledge (TPACK)

Keating and Evans (2001) found that pre-service teachers felt comfortable with ICT in their schoolwork and daily practice, but did not feel confident about using ICT in their future classroom. One possible reason is that the pre-service teachers were lacking "Technological Pedagogical Content Knowledge" (TPACK) (Koehler & Mishra, 2008; Mishra & Koehler 2006). TPACK is a framework for understanding and describing the knowledge needed by a teacher for effective ICT integration. The idea of pedagogical content knowledge (PCK) without the explicit technology aspect was first described by Shulman (1987). TPACK builds on this idea through the inclusion of technology. The TPACK framework argues that effective ICT integration for teaching specific content or subject matter requires understanding of the relationships among three components: ICT/Technology (T), Pedagogy (P), and Content (C) in a certain context. TPACK can be defined as an understanding that emerges from the interaction of Content, Pedagogical, and Technological Knowledge (Koehler & Mishra, 2008). See Fig. 11.1 for a graphical representation.

Or, as Koehler and Mishra (2008) indicated: "At the heart of good teaching with technology are three core components: content, pedagogy, and technology and the relationship between them" (Koehler & Mishra, 2008, pp. 11–12). The TPACK

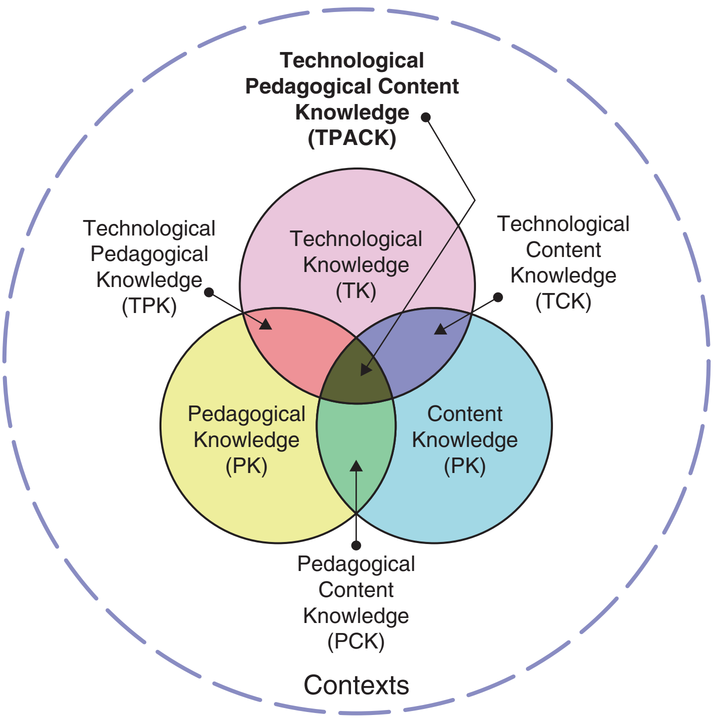


Fig. 11.1 The concept of TPACK. (Adopted from Koehler & Mishra, 2008)

framework gives an overview of three primary forms of knowledge a teacher needs to possess or acquire for ICT integration into their teaching: Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK), as well as the interplay and intersections between them.

The intersection between the different knowledge domains produces Pedagogical Content Knowledge (PCK) which is the knowledge of teaching specific content, as addressed by Shulman (1987). Technological Pedagogical Knowledge (TPK) is an understanding of how teaching and learning change when a particular ICT application is used. Technological Content Knowledge (TCK) is an understanding of the manner in which ICT and content influence and constrain one another. TPACK is the intersection of all three bodies of knowledge (TK, CK & PK). Understanding of TPACK is above and beyond understanding of TK, CK, and PK in isolation, in that it emerges from an interaction of content, pedagogy and technology/ICT.

Learning ICT by Design and Design Teams

The literature has suggested that needs-based, collaborative professional development is effective in developing the competencies teachers need to adequately integrate ICT in their classroom practice (Chandra-Handa, 2001; Figg, 2000; Haughey, 2002; MacDonald, 2008). Kay (2007) conducted a study to compare four strategies used by pre-service teachers to learn about ICT. He found that collaborative strategies for learning were the best predictor of gains in ICT knowledge, and that authentic tasks and collaborative strategies were significant predictors of teacher use of computers in the classroom. Koehler and Mishra (2005) recommended that involving teachers in collaborative authentic problem-solving tasks with ICT is an effective way to learn about ICT, ICT integration processes, and to develop TPACK, a model they called 'learning technology by design' (Koehler & Mishra, 2005).

The learning technology by design approach seeks to put teachers in the role of designers of ICT-enhanced environments as they work collaboratively in small groups to develop ICT solutions to authentic pedagogical problems. By participating in the design process, teachers build competencies that are sensitive to the subject matter (instead of learning the technology in general) and to specific instructional goals (instead of general ones) relevant for addressing the subject matter. In the view of Mishra and Koehler (2003), every act of design is always a process of weaving together components of ICT, content, and pedagogy.

Traditional approaches to learning to use ICT in education make teachers consumers of knowledge about ICT tools, with the hope that they will be able to apply this general knowledge to solving problems in their specific classrooms (Koehler & Mishra, 2005). The learning technology by design approach is based upon different educational strategies that address the potential of design-based activities for learning, such as constructivism or constructionism (Cole, 1997; Harel, 1991; Harel & Papert, 1991; Vygotsky, 1978) and the theory of problem-based learning (Blumenfeld, Marx, Soloway, & Krajcik, 1996; Krajcik et al., 1998). Problem-based learning and learning technology by design often occur over an extended period of time; they are learner-centred, interdisciplinary, ill-structured, and related to the real world by engaging students in authentic activities.

Research Context

The context of this study was the teacher preparation program at the Public Authority of Applied Education & Training (PAAET) in Kuwait, in particular, the science teacher preparation program at PAAET. The teacher preparation program includes some courses on ICT skills, but only as stand-alone ICT skills courses, on the assumption that acquiring ICT skills will lead automatically to effective integration of ICT by pre-service teachers in their future classroom practice.

A feasibility study (Alayyar, 2011) showed that pre-service science teachers at PAAET had a positive attitude toward ICT, that they had basic ICT skills and that they were aware of ICT and its potential role in education. But they were not sure about their ability to integrate ICT into their teaching. They did not consider themselves to be ICT-integrating teachers, which was attributed to the following reasons: (1) the ICT focused courses do not provide students with the ability to integrate ICT in practice; (2) there is limited ICT integration throughout the program, so the pre-service teachers do not experience authentic use of ICT in teaching and learning; and (3) traditional teaching methods are used throughout their preparation program at PAAET.

Based on the previously mentioned results and on a review of the literature, suggestions to support pre-service teachers to better understand and experience the role of ICT in education were proposed: (1) to help pre-service teachers understand how student-centred practices, supported by ICT, impact student learning; (2) to provide pre-service teachers with concrete examples of what teaching with ICT looks like in practice, and to facilitate change in teachers' knowledge and attitudes towards ICT; (3) to provide pre-service teachers with opportunities to explore and experiment with the pedagogical uses of ICT tools to help pre-service teachers to become more confident about integration; and 4) to work in an authentic, collaborative learning environment as a suitable strategy to prepare pre-service teachers to integrate ICT in their future practice.

Research Approach

Design-Based Research

The research approach adopted in our study is design-based research, which is a systematic method characterized by observing and addressing complex problems in their natural setting with the aim to improve educational practice through iterative cycles of analysis, design, development, and implementation. Reeves (2006) indicated that design-based research has two objectives: to develop creative approaches for solving performance or teaching/learning problems, and at the same time to construct a body of design principles that informs theory and could be used to guide efforts in future development. Design-based research is challenging because the researcher not only needs to understand what is happening in a particular context, the researcher should also be able to show the relevance of the findings from the context of the intervention to other contexts.

Research Questions

Two questions guided the research in this study:

1. What changes can be observed in the TPACK, ICT skills, and attitudes toward ICT of pre-service science teachers who participated in DTs?
2. Do Blended Support and Human Support differ in their contribution to these effects?

Intervention

Two iterations of the intervention were studied. For the first iteration, pre-service teachers (n = 61, all female) in the final year of their science education program worked in Design Teams (DTs; three to four pre-service students) and were coached by ICT, pedagogy, and content experts, to find an ICT-related solution for an authentic educational problem that they could encounter in their teaching practice. The DTs had to select science content and a suitable ICT tool for teaching this content, taking into account the affordances and constraints of the tool, and to determine teaching strategies for using ICT with a learner-centred focus. At the end of the course, the DTs had to present their solution in class, together with a lesson plan, and an ICT integration plan. The intervention lasted 12 weeks, 2 hours per week.

In the second iteration, the pre-service teachers (n = 78, all female) were separated into two groups; the first group was offered human support (HS; n = 22, all female) from an ICT, pedagogy and content expert (similar to the previous study) and the second group was offered blended support (BS; n = 56, all female), In the BS-condition, the experts did not attend the class unless the DTs needed them. The BS was an online support portal in Moodle, which contained tutorials on how to use different kinds of software, examples of lesson plans that integrate ICT, a matrix of different ICT applications with suitable teaching methods, and examples or URL links on using ICT in science education. The portal also provide online expert support through a chat tool and offered a workplace for DTs to share documents, and a discussion forum to reflect on what was going on in class, and to answer weekly questions. Besides using the portal, the pre-service teachers in the BS condition had the opportunity to consult the experts face to face. The assignment for the pre-service teachers was similar to the first iteration. This intervention also lasted 12 weeks, 2 hours per week.

Data Collection and Analysis

Several instruments were used to answer the research questions. Data were collected at the start and end of the intervention to determine pre-service teachers' development of TPACK, their ICT skills and their attitudes towards ICT. The following instruments were administered: the TPACK survey (Schmidt et al., 2009), the ICT skills test and the ICT skills questionnaire [based on Milken Exchange on Educational Technology (1999) and the Technology Proficiency Self-Assessment (TPSA; Ropp, 1999)] and the Teachers' Attitude toward Computers questionnaire (TAC; Christensen & Knezek, 1996).

At the end of the intervention, the DTs were asked to submit a logbook in which they described the problems they faced during the design process, how they solved these problems, from whom they got support and assistance, and the different activities that occurred within the DT during the design process.

In the first iteration, the pre-service teachers completed an attitude toward teamwork questionnaire to understand their attitude towards working in teams; they also participated in a semi-structured interview to assess individual student opinions about their TPACK understanding and experience, and the support and help a DT needs during the design process. In the second iteration, the teams participating in the BS condition were interviewed to gather their opinion about the BS. To assess pre-service students' understanding of TPACK and whether they could relate TPACK to their practice or experience during their in-school training or within their preparation program, all students were asked to provide a written reflection on those topics.

To analyse the quantitative data, means and standard deviations were calculated. Inferential statistics were used to determine differences between pre-post measures and/or different conditions (second iteration). To analyse student understanding of TPACK (first iteration: semi-structured interviews; second iteration: TPACK reflection questionnaire), an assessment rubric (Alayyar, Fisser, & Voogt, 2011) was used. The logbooks were analysed by grouping the ICT needs or problems into different groups in relation to TPACK; then items related to TK were sub-grouped according to their functions, such as photo editing, video editing, presentation, sound editing, animation, tables, and database. Students' opinions about BS (second iteration) were summarized.

Main Findings

First Iteration: TPACK and Teacher Design Teams

It was expected that by working in DTs, the pre-service science teachers would experience student-centred practices through an authentic, active and collaborative learning environment. Designing an ICT-enhanced lesson would give the pre-service science teachers opportunities to explore and experiment with the ICT tools and to experience the pedagogical uses of ICT tools in order to understand what teaching with ICT will look like in practice and how integration of ICT in science curriculum will impact student learning, and would provide the pre-service science teachers with concrete examples of effective ICT integration in science education. The whole experience would support the development of competencies needed by pre-service science teachers for ICT integration.

The findings of this study showed that during the design process, the pre-service science teachers developed their ICT skills and started thinking about ICT as a tool for achieving instructional objectives, rather than considering ICT as an end in itself. The pre-service teachers became active learners, collaborated with different team members, learned by doing and experimented with different kinds of ICT tools to solve the pedagogical problems they encountered. This study provided pre-service science teachers at PAAET with the competencies required for an ICT-integrating teacher. The results of the study showed that the ICT skills of the pre-service teachers increased significantly after they worked in DTs to develop or design a solution for a problem related to the specific science content by using a suitable pedagogy and appropriate ICT tools. The pre-service teachers developed a positive attitude toward both ICT and teamwork, and their TPACK had increased after working in DTs. This meant that the pre-service teachers had positive experiences with using ICT and gained ICT-related skills. Additionally, the pre-service teachers reported an increase in the usefulness and ease of ICT use at the end of the intervention, which indicated that the pre-service teachers supposedly increased their confidence and competence in using ICT. The findings provided evidence that having the pre-service science teachers at PAAET work in a DT fostered their development of TPACK.

Second Iteration: Blended Support for Learning

From the first iteration, the experts who coached the pre-service science teachers indicated that the face-to-face support they provided to the DTs during the course was essential in guiding students' thinking toward TPACK. However, both the experts and the pre-service science teachers acknowledged that supporting the DTs face-to-face was time consuming and asserted that more flexibility related to time and delivery would be an important feature of an environment supporting the development of TPACK in DTs. Beside the flexibility, the pre-service teachers stressed the need for a support system or environment in the Arabic language. Since students at the teacher preparation program at PAAET are used to a teacher-centred approach, an online environment that completely replaced the support of the expert instructors therefore might not be an effective strategy. For this reason, a blended approach to supporting the DTs was explored in this study. The second iteration intended to explore whether providing BS (on-line support along with face-to-face support by expert instructors) for learning could be an effective and efficient alternative to support the development of TPACK in the pre-service science teachers while working in DTs.

The results from this iteration indicated that both the HS and BS conditions showed significant positive effects on the pre-service teachers' attitude, knowledge, and skills needed for ICT integration. This leads to the conclusion that human support and blended support conditions are successful alternatives for supporting the pre-service teachers. However, pre-service teachers in the BS condition showed higher gains in positive attitudes toward ICT, Technological Pedagogical Knowledge (TPK), and Technological Knowledge (TK). No differences between the two conditions were found in the anxiety and frustration constructs toward computers, ICT skills (test and survey) and – except for TK and TPK – the other aspects of TPACK. Based on the findings of this study it was concluded that applying the DTs approach combined with BS is beneficial for the pre-service teachers and the instructors who guide them. The pre-service teachers showed higher gains in positive attitudes toward ICT, TPK TK, they became more experienced with ICT use, and they experienced a student-centred approach. For the instructors, the BS for learning meant an effective and, above all, a more efficient way of supporting the pre-service teachers.

Conclusion

This study used DTs as a pedagogical approach to prepare pre-service science teachers for ICT integration in their practice. The findings of this study showed that ICT integration through working in DTs proved to be a promising strategy in pre-service teacher education programs, for several reasons. First, it helped to develop the competencies of pre-service teachers at PAAET for ICT integration. By using DTs, the pre-service science teachers learned about ICT tool affordances and constraints for solving teaching and learning problems, ICT-related skills, and design processes. This approach to ICT integration moved pre-service teachers from being passive learners and consumers of ICT to being more active learners and producers/designers of ICT by learning how to use existing hardware and software in creative and situation-specific ways to accomplish their teaching goals. Subsequently, they were able to integrate the available ICT in their daily lesson plans and classroom practice. This not only led to more and effective integration of ICT in teaching and learning, but pre-service teachers also experienced a student-centred approach, which they can apply in their future teaching activities. Second, working in DTs and engaging in the design process for educational reform have been shown to generate greater ownership and commitment toward the education reform (Cviko, McKenney, & Voogt, 2015; Nieveen, Handelzalts, & Van den Akker, 2005) This means that working in DTs on ICT integration during their pre-service teacher education program at PAAET may strengthen the ownership of the pre-service teachers toward the ICT integration process. Kereluik et al. (2010) indicated that it is important to realize that ICT-based interventions will not reach fruition unless the teachers take ownership. It is therefore recommended that the teacher preparation program at PAAET adopt the DT approach in its curriculum in order to realize ICT integration not only in the future practice of the pre-service teachers, but also in the teacher preparation program itself.

The results of this study showed that both HS and BS are effective in developing the competencies and attitudes pre-service teachers need to integrate ICT in their teaching. The BS environment also included the possibility of communication among team members, between different teams, and with the course instructor. The pre-service teachers and the expert instructors appreciated the BS with the combination of support and guidance provided by the instructors and the flexibility of an online environment. An advantage of BS over HS was that the pre-service teachers experienced the use of ICT tools in an ICT environment for their own learning. In addition, the BS mode is more than the HS mode in providing the pre-service teachers with experiences in learning through a student-centred approach. These experiences suggest that at PAAET, DTs in a BS mode could be a useful format for supporting pre-service teachers in developing their abilities for the integration of ICT.

Extra time is needed to get used to, and to practice ICT competencies in real classroom settings (Tondeur, Pareja Roblin, van Braak, Voogt, & Prestridge, 2017). Sustaining the development of TPACK needs to be fostered through real teaching experiences because building a strong TPACK knowledge base is a long-term trajectory that goes beyond pre-service teacher education in formal settings (Fishman & Davis, 2006; Voogt, Fisser, Tondeur, & van Braak, 2016). Therefore, it is recommended that graduates of the teacher preparation program should have the opportunity to engage in lifelong learning opportunities through an additional (in-service) program. This could be done by providing an online learning support system that could help pre-/in-service teachers in the development of ICT integration in education. This environment can act as a learning support, and also as a communication tool to exchange ideas among peers and experts. At the same time, the teachers will learn about ICT integration by doing (Tran, Berg, Ellermeijer, & Beishuizen, 2015).

This study focused on the development of the attitudes, knowledge and skills needed by pre-service teachers to be able to integrate ICT in their future teaching practice. The development of competencies needed to integrate ICT in teaching and learning practices is a long-term trajectory. To better understand and support the professional learning of practicing teachers regarding the use of ICT for teaching and learning in DTs, further research is needed to guide the organization, composition and activities of DTs for fostering the development of TPACK in practicing teachers.

References

Alayyar, G. (2011). *Developing pre-service teacher competencies for ICT integration through design teams* (Doctoral dissertation). Enschede, the Netherlands: University of Twente.

Alayyar, G., Fisser, P., & Voogt, J. (2011). ICT integration through design teams in science teacher preparation. *International Journal of Learning Technology, 6*(2), 125–145.

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in Technological Pedagogical Content Knowledge (TPCK). *Computers & Education, 52*(1), 154–168. https://doi.org/10.1016/j.compedu.2008.07.006

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers & Education, 39*(4), 395–414. https://doi.org/10.1016/s0360-1315(02)00075-1

Becker, H. J. (2001). *How are teachers using computers in instruction?* Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Blumenfeld, P. C., Marx, R. W., Soloway, E., & Krajcik, J. (1996). Learning with peers: From small group cooperation to collaborative communities. *Educational Researcher, 25*(8), 37–40.

Chandra-Handa, M. (2001). Leading academic change – Through connective leadership and learning. In J. Price et al. (Eds.), *Proceedings of Society for Information Technology & teacher education international conference 2001* (pp. 488–493). Chesapeake, VA: AACE.

Chen, C. H. (2008). Why do teachers not practice what they believe regarding technology integration? *The Journal of Educational Research, 102*(1), 65–75.

Christensen, R., & Knezek, G. (1996). *Constructing the Teachers' Attitudes toward Computers (TAC) questionnaire*. Paper presented at the Southwest Educational Research Association Annual Conference, New Orleans, LA.

Churchill, D. (2009). Educational applications of web 2.0: Using blogs to support teaching and learning. *British Journal of Educational Technology, 40*(1), 179–183. https://doi.org/10.1111/j.1467-8535.2008.00865.x

Cole, M. (1997). *Cultural psychology: A once and future discipline*. Cambridge, MA: The Belknap Press of Harvard University Press.

Cviko, A., McKenney, S., & Voogt, J. (2015). Teachers as co-designers of technology-rich learning activities for emergent literacy. *Technology, Pedagogy and Education, 24*(4), 443–459. https://doi.org/10.1080/1475939X.2014.953197

Doering, A., Veletsianos, G., Scharber, C., & Miller, C. (2009). Using the technological pedagogical, and content knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research, 41*(3), 319–346.

Figg, C. B. (2000). *Relationships between selected elementary teachers' beliefs and educational technology use* (Unpublished dissertation). Austin, TX: University of Texas.

Fishman, B., & Davis, E. (2006). Teacher learning research and the learning science. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 535–550). New York: Cambridge University Press.

Harel, I. (1991). *Children designers: Interdisciplinary constructions for learning and knowing mathematics in a computer-rich school*. Norwood, NJ: Ablex Publishing Corporation.

Harel, I., & Papert, S. (1991). *Constructionism*. Norwood, NJ: Ablex Publishing Corporation.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education, 41*(4), 393–416.

Haughey, M. (2002). *Canadian research on information and communications technologies: A state of the field*. Retrieved May 15, 2011 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.84.998&rep=rep1&type=pdf

Jimoyiannis, A. (2008). Factors determining teachers' beliefs and perceptions of ICT in education. In A. Cartelli & M. Palma (Eds.), *Encyclopaedia of information communication technology* (pp. 321–334). Hershey, PA: IGI Global.

Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development. *Computers & Education, 55*(3), 1259–1269. https://doi.org/10.1016/j.compedu.2010.05.022

Kay, R. (2007). A formative analysis of how pre-service teachers learn to use technology. *Journal of Computer Assisted Learning, 23*(5), 366–383.

Keating, T., & Evans, E. (2001). *Three computers in the back of the classroom: Pre-service teachers' conceptions of technology integration*. Paper presented at the Annual meeting of the American Educational Research Association, Seattle, WA.

Kelly, M. G. (Ed.). (2002). *National educational technology standards for teachers: Preparing teachers to use technology* (1st ed.). Eugene, OR: International Society for Technology in Education.

Kereluik, K., Mishra, P., & Koehler, M. (2010). Reconsidering the T and C in TPACK: Repurposing technologies for interdisciplinary knowledge. In D. Gibson & B. Dodge (Eds.), *Proceedings of SITE 2010 – Society for Information Technology & teacher education international conference* (pp. 3892–3899). San Diego, CA: Association for the Advancement of Computing in Education (AACE). http://www.editlib.org/p/33987

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Koehler, M. J., & Mishra, P. (2008). Introducing TPCK. In The AACTE Committee on Innovation and Technology (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3–29). New York: Routledge.

Koehler, M. J., Mishra, P., Hershey, K., & Peruski, L. (2004). With a little help from your students: A new model for faculty development and online course design. *Journal of Technology and Teacher Education, 12*(1), 25–55.

Krajcik, J. S., Blumenfeld, P., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Middle school students' initial attempts at inquiry in project-based science classrooms. *The Journal of the Learning Sciences, 7*, 313–350.

MacDonald, R. J. (2008). Professional development for information communication technology integration: Identifying and supporting a community of practice through design-based research. *Journal of Research on Technology in Education, 40*(4), 429–445.

Milken Exchange on Educational Technology Report. (1999). *Will new teachers be prepared to teach in a digital age? A national survey on information technology in teacher education*. Retrieved on 22 June 2009. Available at http://www.milkenexchange.org/research/iste_results.html

Mishra, P., & Koehler, M. J. (2003). Not "what" but "how": Becoming design-wise about educational technology. In Y. Zhao (Ed.), *What teachers should know about technology: Perspectives and practices* (pp. 99–122). Greenwich, CT: Information Age Publishing.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Nieveen, N., Handelzalts, A., & Van den Akker, J. (2005). *Teacher design teams in view of school-based curriculum development*. Paper presented at the American Educational Research Association Annual Meeting, Montreal, Canada.

Palak, D., & Walls, R. T. (2009). Teachers' beliefs and technology practices: A mixed methods approach. *Journal of Research on Technology in Education, 41*(4), 417–441.

Reeves, T. C. (2006). Design research from a technology perspective. *Educational Design Research, 1*(3), 52–66.

Ropp, M. M. (1999). Exploring individual characteristics associated with learning to use computers in pre-service teacher preparation. *Journal of Research on Computing in Education, 31*(4), 402–424.

Sang, G., Valcke, M., van Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviours with educational technology. *Computers & Education, 54*, 103–112.

Schmidt, D. A., Baran, E., Thompson, A. D., Punya, M., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. *Journal of Research on Technology in Education, 42*, 123–149.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–22.

Tondeur, J., Roblin, N. P., van Braak, J., Fisser, P., & Voogt, J. (2013). Technological pedagogical content knowledge in teacher education: In search of a new curriculum. *Educational Studies, 39*(2), 239–243. https://doi.org/10.1080/03055698.2012.713548

Tondeur, J., Aesaert, K., Pynoo, B., van Braak, J., Fraeyman, N., & Erstad, O. (2016). Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century. *British Journal of Educational Technology, 48*, 462–472.

Tondeur, J., Pareja Roblin, N., van Braak, J., Voogt, J., & Prestridge, S. (2017). Preparing beginning teachers for technology integration in education: Ready for take-off? *Technology, Pedagogy and Education, 26*(2), 157–177.

Tran, B., Berg, E., Ellermeijer, T., & Beishuizen, J. (2015). Development of a course on integrating ICT into inquiry-based science education. Three case studies in The Netherlands. *Nuovo Cimento C, 38*(3), 1–18.

Vannatta, R. A., & Fordham, N. (2004). Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education, 36*(3), 253–271.

Voogt, J., Fisser, P., Tondeur, J., & van Braak, J. (2016). Using theoretical perspectives in developing an understanding of TPACK. In M. Herring, M. J. Koehler, & P. Mishra (Eds.), *Handbook of technological pedagogical content knowledge (TPACK) for educators* (2nd ed., pp. 33–51). New York: Routledge.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wetzel, K., Wilhelm, L., & Williams, M.K. (2004). The introductory technology course: A tool for technology integration. *Contemporary Issues in Technology and Teacher Education* [Online serial], *3*(4). Retrieved from http://www.citejournal.org/vol3/iss4/general/article4.cfm

Zhao, Y. (Ed.). (2003). *What should teachers know about technology? Perspectives and practices*. Greenwich, CT: Information Age Publishing.

Zhao, Y., & Bryant, F. L. (2006). Can teacher technology integration training alone lead to high levels of technology integration? A qualitative look at teachers' technology integration after state mandated technology training. *Electronic Journal for the Integration of Technology in Education, 5*, 53–62.

Zhao, Y., Pugh, K., & Sheldon, S. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104*(3), 482–515.

Chapter 12
Facilitator and Peer Support in Collaborative Curriculum Design

Arkato Gendole Anto and Fer Coenders

Introduction

English is the language of instruction in Ethiopian higher education, but most students have inadequate command of English (Kahsay, 2012). Communicative language teaching (CLT) is a widely accepted approach to language teaching (Gray & Klapper, 2009; Harmer, 2007; Richards, 2006) that can address this problem. CLT emphasizes the development of students' communicative competence, ability to use language for meaningful communication, and ability to produce grammatically correct sentences in a language (Richards, 2006; Richards & Farrell, 2005).

However, the quality of English language teaching in Ethiopian higher education is challenged due to under-qualified teachers (MoE, 2005). Based on the results of a needs and context analysis (Anto, Coenders, & Voogt, 2012), a collaborative professional development program (CPDP) (Austin, 2002; Loucks-Horsley, Hewson, Love, & Stiles, 2010) aimed at promoting communicative language teaching (CLT) by university English language teachers was designed and piloted at an Ethiopian university. The CPDP was intended to help the teachers improve their CLT knowledge and skills in order to improve student learning, engage the teachers in student-centered learning approaches, and have teachers collaborate with their colleagues and support each other's professional learning. Facilitators, teachers recognized for their professional compentencies, their cooperativeness and their reputation among fellow teachers, played essential roles in the CDPD. Facilitators were subject specialists, instructional specialists, change agents and mentors for their colleagues.

A. G. Anto
School of Graduate Studies, Arba Minch University, Arba Minch, Ethiopia

F. Coenders (✉)
Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands
e-mail: f.g.m.coenders@utwente.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_12

In a context where many teachers lack prior teacher education and have limited teaching experience, as in Ethiopian higher education, it might be difficult to depend totally on facilitators for sustainable support of teacher learning and implementation of innovative instructional approaches such as CLT. Peer support is often reported as an alternative support for sustainable use of innovative teaching approaches (Topping, 1996). The main purpose of this study was to explore whether peers could take over the mentor role from the facilitators during CLT implementation. Hence, in this study, peer support is compared to the mentoring role as enacted through facilitator support, with respect to effects on teaching practice, student learning and teacher learning.

Theoretical Underpinnings

Communicative Language Teaching (CLT)

CLT encourages interactive language learning through authentic communication to students in a meaningful way (Gray & Klapper, 2009; Richards, 2006). CLT is characterized by: (a) involving students actively in the teaching-learning process; (b) using students' authentic experiences and materials as inputs for language learning; (c) providing students with chances for practicing and using new language items in their real communication; (d) facilitating students' collaborative learning; (e) using an integrated-skills approach (combining all skills); (f) communicating language learning purposes to learners; (g) teaching grammar/vocabulary in contextualized texts; (h) integrating assessment with language teaching; (i) tolerating students' language errors; and (j) using the target language for communication in the classroom. As a result, CLT fosters the social relationship between the teacher and learner, makes students have a sense of ownership of their own learning, and thereby enhances their motivation (Richards, 2006; Tsai, 2007; Ur, 2003).

Mentoring and Peer Coaching as Strategies of Professional Development

Mentoring and peer coaching are teacher professional development strategies that involve two or more teachers working together towards the improvement of their professional knowledge, skills and classroom practices (Guskey, 2000; Loucks-Horsley et al., 2010; Richards & Farrell, 2005). They can bring teachers together who might not normally have a chance to interact and provide opportunities for them to share ideas and expertise and a chance to discuss professional problems and concerns. Teachers can grow professionally as they develop themselves in their profession (Richards & Farrell, 2005). The difference between mentoring and peer coaching lies in the hierarchical relationship of the participants, as explained below.

Mentoring refers to a professional learning strategy whereby an experienced teacher provides guidance and feedback to a novice teacher (Richards & Farrell, 2005). Regular opportunities for discussion about professional goals, sharing of ideas and successful practices, reflection on ongoing practices, on-the-job observations and strategies for improvement are arranged (Guskey, 2000). Mentoring relationships can benefit both the mentor and the mentee (Guskey, 2000; Richards & Farrell, 2005; Triple Creek Associates, 2007). Mentors are helped by sharing their own expertise with a colleague and expanding it, by improving their leadership skills (Richards & Farrell, 2005; Triple Creek Associates, 2007), and by gaining new insight into an issue when a mentee explains why he or she does a certain activity (Loucks-Horsley et al., 2010). It also triggers the mentor to reflect on his or her own teaching when observing a mentee's teaching (Richards & Farrell, 2005). Similarly, when working with mentors, mentees can build on their existing expertise, knowledge and teaching skills as they try new teaching strategies, enact a new curriculum and receive feedback and reflect on their new practices (Loucks-Horsley et al., 2010).

In this study, we use the definition from Richards and Farrell (2005) for peer coaching: a process of reciprocal relation in which colleagues work together to reflect on current practices, expand, refine, and build new skills, share ideas; teach one another; conduct classroom research; or solve problems in their instructional process. Like mentoring, peer coaching is an ongoing process that involves a training stage followed by various other extended activities such as classroom teaching and lesson observation, providing of feedback and critical reflection on class performance by the teacher being coached (Galbraith & Anstrom, 1995). It provides opportunities for participating teachers to look at teaching problems and to develop possible solutions, and it develops collegiality between colleagues (Richards & Farrell, 2005). It offers benefits to both the coaching and coached teacher. The coaching teacher gets the satisfaction of helping a colleague, renews his or her own teaching through the coaching process and gets professional recognition from serving as a coach. The coached teacher gains knowledge from a trusted peer, receives constructive, nonthreatening feedback on his or her teaching practices, and thereby expands his or her teaching repertoires. Coached teachers experience significant positive changes in their knowledge and behaviors when they receive appropriate support and specific feedback over an extended time (Joyce & Showers, 2002). Moreover, peer coaching reduces the sense of isolation that teachers tend to feel (Richards & Farrell, 2005).

Richards and Farrell (2005) considered lesson observation, feedback provision and reflective discussion as essential components of effective mentoring and peer coaching. A teacher observes a colleague's lesson and notes important points for later reflective feedback and discussion. In conducting the observation, the observer may focus on lesson design, lesson execution and classroom management or other issues (Guskey, 2000). To promote teacher learning and to improve classroom teaching practice, feedback and reflection should be non-judgmental and non-evaluative (Thorn, McLeod, & Goldsmith, 2007).

The Collaborative Professional Development Program (CPDP)

The CPDP had three components: a seminar, an implementation phase and an evaluative workshop (see also Fig. 12.1). During the *seminar*, the teachers were trained on the *essentials of CLT* by an expert in English teaching, supported by the facilitators and the researcher. In design teams, supervised by the facilitators, the teachers collaboratively designed and practiced micro-lessons with the help of teacher guides, and collectively discussed and reflected on the design and practice of the micro-lessons. During the *implementation phase,* the teachers were split into two groups. Three teams consisting of two teachers and one facilitator each (facilitator-supported teachers; FST); and three teams in which two teachers supported each other (peer-supported teachers; PST) were formed. The teachers taught lessons in the course *Communicative English Skills* and were observed by a peer or a facilitator. In principle, each teacher was observed three times. For each observation, each teacher had pre- and post-observation meetings with the supporting peer or facilitator about the lesson plan and lesson implementation. During lesson execution, the observing peer or facilitator rated the observed teacher's instructional activities with the help of an observation checklist. After execution, first the observed colleague reflected on his/her teaching performance, after which the observing peer or facilitator offered feedback on the lesson implementation, focusing on (1) CLT practice features done successfully, (2) CLT practice features needing improvement and (3) how these could be improved. After agreeing on these issues, the observed colleague jotted down points needing consideration in the following lesson.

During the *evaluative workshop,* experiences regarding the CDPD were shared. The facilitators and the peer coaches received 4 h preparation training for the role they assumed during the implementation phase. The training included a presentation by the researcher on activities and procedures of effective mentoring/peer coaching (lesson observation, providing of feedback, individual and group reflection). As the facilitators also had roles in supporting teachers during the seminar,

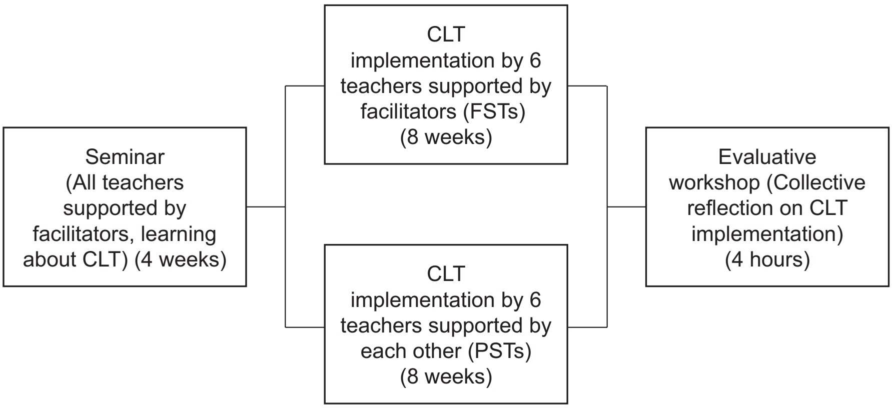


Fig. 12.1 The components and activities of CPPD

their training included an additional 6 h, which was spent on CLT features, the collaborative design of teacher guides for certain lessons of *Communicative English Skills*, and discussions and reflections on the teacher guides.

Research Questions

The focus of this study is on comparing the effects of *facilitator support* and *peer support* during the *CLT implementation phase* (see Fig. 12.1) on the teachers' CLT practice, on their students' learning experiences, and on the teachers' CLT knowledge and beliefs. Teachers' teaching practice, their students' learning, and teachers' self-reported learning are considered as indicators for teacher learning of CLT (Guskey, 2000).

> What are the effects of facilitator support and peer support on English language teachers' CLT practice, on their students learning experiences, and on the teachers' own learning?

Specific questions

1. How did the classroom teaching practices of facilitator-supported teachers (FSTs) and peer-supported teachers (PSTs) change after CLT implementation?
2. What changes in student learning were found as a result of the implementation of CLT lessons by FSTs and PSTs?
3. What learning gains (knowledge, skills and beliefs) are reported by FSTs and PSTs and how did CLT implementation contribute to these learning gains?

A case study design (Yin, 2003) using two teacher groups (FSTs and PSTs) as units of analysis was applied to explain teachers' learning in CPDP.

Methods

Participants

Facilitators

Three experienced teachers, Ale, Aba and Gat, acted as facilitators. They had 7, 6 and 5 years teaching experience, respectively, and were between 26 and 29 years old. Each of them had an MA in teaching English as a foreign language (TEFL). They were selected in consultation with the department head for their well-recognized professional competencies, their cooperativeness, their reputation and acceptance among fellow staff members (cf. Lieberman & Mace, 2009; Lieberman & Miller, 2004).

Teachers

Twelve novice bachelor's degree holding teachers (10 males; 2 females) who were teaching *Communicative English Skills* at the time of the program implementation participated in the study. While ten of them had 2 years of teaching experience, the remaining two each had only 1 year of experience. They were between 22 and 25 years old. Six of them had some experience with CLT but the other six did not have any CLT preparation. When assigning the teachers to peer (PST) or facilitator (FST) support, four pairs indicated that they wanted to be supported by peers, and the other two wanted facilitators. One pair was easily willing to change from peer to facilitator support. Therefore, the PST group consisted of three pairs of teachers, and the FST group of three pairs of teachers mentored by a facilitator. Six teachers (one from each pair) were randomly selected to be interviewed and to participate in lesson observation.

Students

All students of the sections in which the teachers taught *Communicative English Skills* completed pre-post intervention questionnaires on the teachers' CLT practices. Two student groups were formed to conduct pre-post intervention focus group discussions, composed of students taught by the FSTs and PSTs who participated in interviews and lesson observation. Each group consisted of six students drawn from three classes (two from each) in which each type of teacher group taught the stated course. The selection was done in consultation with the department head regarding the students' ability to provide genuine information about the issues addressed.

Instruments

A *teacher questionnaire* solicited information from the teachers on their CLT knowledge, beliefs, and practice before and at the end of the intervention. The *teacher interview* was conducted before and after the intervention with three FSTs and three PSTs (one from each of six pairs) on issues similar to those addressed by the questionnaire to supplement the data collected via the questionnaire (Miles & Huberman, 1994). *Lesson observation* was used to collect data on teachers' teaching practice. The *facilitator interview* was used to obtain data on the facilitators' perceptions about teachers' learning and changes in CLT practice. The *student questionnaire* was employed before and after the intervention to solicit information on teachers' CLT practice. Two *focus group discussions (*before and after the intervention) were held with each student group to obtain data on changes in the teachers' CLT practice and student learning experiences as a result of CLT implementation.

Data Analysis

Descriptive statistics (means and standard deviations) and non-parametric tests (Wilcoxon signed ranks test/Mann-Whitney test) were applied to analyze the student questionnaire data. The reliability of the student questionnaire was calculated (Cronbach's α) for two teaching practice constructs, general CLT practice ($\alpha = 0.79$, 12 items) and listening skill practice ($\alpha = 0.82$, 8 items). Data collected via interviews, observations and focus group discussion were analyzed qualitatively using data reduction and data display techniques (Miles & Huberman, 1994). Data obtained through interviews were transcribed, transported into Atlas.ti (Version 6.2) and analyzed to create thematic codes. Nine thematic codes were generated using deductive coding. Sample interview quotations were re-coded by another coder to check inter-coder reliability of the data. The agreement was found to be excellent (Cohen's $\kappa = 0.89$).

Findings

Change in Teaching Practice

To see the effects of the intervention on CLT practice by FSTs and PSTs, a Wilcoxon signed ranks test on the student questionnaire data was conducted for the two teacher groups. The results showed that, according to their students, both teacher groups made significant improvements in their *general CLT practice* and *listening skill practice* between pre- and post-intervention (Table 12.1).

A Mann-Whitney test showed that PSTs had significantly higher gains than FSTs with regard to *general CLT practice* after CLT implementation No significant difference was noticed between the teacher groups for *listening skill practice* (Table 12.2).

Table 12.1 Effects on FSTs and PSTs CLT practice (according to students)

Teacher groups	Constructs of teaching practice	N	Pre intervention	Post intervention	Z	p	Effect size
			M(SD)	M(SD)		(1-tailed)	(Cohen's d)
FSTs	General CLT practice	187	3.2 (0.48)	3.5 (0.45)	−7.4	0.001	0.8
	Listening skill practice	188	3.1 (0.63)	3.5 (0.47)	−7.3	0.001	0.8
PSTs	General CLT practice	186	3.2 (0.54)	3.7(0.46)	−8.0	0.001	1.0
	Listening skill practice	182	3.1(0.70)	3.7 (0.48)	−8.4	0.001	1.0

Table 12.2 Mean gains in CLT practice by FSTs and PSTs (according to students)

	FSTs	PSTs			
	M(SD) (N = 188)	M(SD) (N = 186)	Z	p (2-tailed)	Effect size (Cohen's d)
General CLT practice	0.3 (0.50)	0.4 (0.67)	−2.2	0.03	0.2
Listening skill practice	0.4 (0.69)	0.5 (0.82)	−1.2	0.2	0.1

In the following sections, the changes in practice observed by the students are reported.

FSTs' Changes in Practice

During the focus group discussion, students of FSTs explained that *before the CPDP*, their teachers showed limited CLT practice in their teaching. All three of the teachers facilitated students' collaborative learning. In addition, two teachers (Abt and Hah) involved students actively in the teaching-learning process and predominantly used English in classroom communication.

After their participation in the CDPD, the three FSTs used authentic materials and experiences in their teaching, provided chances for students to practice and use the new language items inside and outside the classroom, communicated lesson objectives to students at the start of each lesson, and used audio materials for teaching listening skill, as reported by students and, in most cases, validated by facilitators (Table 12.3). Regarding practicing and using the taught language items, one of Abt's students reported, "*Now, our teacher usually makes students practice what they learned for real communication. For example, after teaching reported speech, he let one student say something and another student report it to the class*." Dam and Hah tolerated students' language errors and used formative assessment techniques to check the progress of student learning. Concerning formative assessment techniques, one of Hah's students stated, "*The teacher assessed most of our language learning by continuous classroom observation of our communicative activities and provision of simple quizzes. Consequently, she reduced the weight of the semester-end exam to assess student learning.*"

Facilitators' interviews confirmed that the teachers changed their CLT practice. But the facilitators also expressed that there were issues that needed further improvement. For instance, one of them said, "*I observed improvements in the teachers' practices, possibly caused by their new learning gains in CLT features but still they need to further improve certain issues like involving students actively in their lessons, integrating assessment with language teaching, etc.*"

Table 12.3 Teachers' changes in CLT practice

CLT features and related issues	Teachers (pseudonyms)					
	FSTs			PSTs		
	Abt	Dam	Hah	Dab	Tat	Mag
	Reported after intervention by					
Use of students' authentic materials and experiences	Students	Facilitator	Students	Students	Students	Students
	Facilitator				Peer	Peer
Provision of chances for students to practice and use language items	Students	Students	Students			
	Facilitator		Facilitator			
Communication of lesson objectives	Students	Students	Students		Students	Students
	Facilitator	Facilitator	Facilitator		Peer	Peer
Contextualization of grammar and vocabulary teaching					Students	Students
						Peer
Integration of assessment with language teaching		Students	Students		Students	Students
			Facilitator		Peer	Peer
Treatment of students' language errors		Students	Students	Students	Students	Students
		Facilitator		Peer	Peer	Peer
Use of audio text to teach listening	Students	Students	Students	Students	Students	Students
	Facilitator	Facilitator	Facilitator	Peer	Peer	Peer

PSTs' Changes in Practice

Students from classes taught by PSTs reported that *before the CDPD* their teachers demonstrated very few CLT features in their teaching. They facilitated students' collaborative language learning, provided opportunities for practice and use of new language items in their daily communication. Students of two teachers (Tat and Mag) added that their teachers actively involved students in the teaching-learning process and predominantly used English in classroom communication.

However, *after the CPDP*, as seen in Table 12.3, the students of the three PSTs indicated that their teachers used students' authentic materials and experiences in their teaching, tolerated students' language learning errors and used audio material to teach listening lessons. For instance, a student from Mag's class expressed, "*In teaching listening, the teacher now uses audio text that we listen to from a laptop. He never used this before. Every student found it interesting.*" This was also confirmed by their peers. Moreover, students of Tat and Mag disclosed that, after the intervention, their teachers began to communicate lesson objectives, taught grammar and vocabulary in context, and applied formative assessment techniques to assess their students' language learning. One of Tat's students said, "*As a new experience, he now communicates lesson objectives at the start of each lesson.*"

During interview conversations, Tat and Mag showed their agreement with most of the changes in practice reported by their respective students. Tat, who was said to use limited CLT features before the intervention, revealed his change in practice after the intervention, "*I started to tolerate student mistakes and more encouraged the students for their every effort of language learning (I was a fault finder), communicated lesson objectives at the start of each lesson, used audio text to teaching listening skill lessons etc.*" However, after the CPDP, although Dab reported applying students' authentic experiences in his teaching, teaching grammar and vocabulary items in context and using audio texts to teach listening skill, his use of authentic materials and teaching of grammar and vocabulary items in context were not verified by his students and his peer. Moreover, he appeared to have low interest in the CPDP as he missed many workshop sessions during the seminar.

Student Learning Gains

Student learning is considered to be the ultimate goal of teacher professional development (Guskey, 2000). For this reason, we also asked students to report on their learning and asked teachers how they perceived student learning. Student learning in this study refers to their increased motivation to learn English and their increased participation in the teaching-learning process, not to improved language skills, because achieving this needs a longer period of time. In the next sections we report the changes reported by students of FSTs and PSTs about their motivation for and participation in learning English.

Students Taught by FSTs

Students of FSTs explained that *before the CPDP* their participation in the teaching learning process was quite limited and their motivation to learn English was low. *After the intervention*, as they reported and teachers confirmed most of these reports, the students were more motivated to learn the language and increased their involvement in the teaching-learning process. All participating students revealed that their interest in learning the language increased, they spent more time doing different communicative activities, they engaged more intensively in group work, they started learning through listening to audio materials and liked it a lot, they became more confident about contributing to group/pair work and speaking in front of others, and they established a smoother rapport with their teachers. They added that they appreciated this more engaging and interactive approach to language teaching used by their teachers. Concerning student motivation to learn English, a student from Dam's class said, "*After observing the keen interest of students to learn English, our teacher said, 'I will teach this your next course again'.*" Hah's student also noticed changes in the students' learning experience, "*After our last discussion, student involvement in the teaching learning process increased. Most of the time, students worked in groups and group members took various roles such as ambassador, secretary, leader, time keeper in carrying out various communicative activities.*" Dam's students added that, after the intervention, they felt more responsible for their own learning. Abt's students also commented that they were encouraged to ask and answer questions, became more delighted with their learning and appreciated their teacher's new teaching approach. One of his students stated, "*As our teacher moves around and prompts everybody to contribute to group/pair work, most students are now happy to actively engage in diverse learning tasks and to ask and answer questions. Most of them appreciate his new approach of teaching.*"

FSTs verified most of the student learning changes reported by their students. For instance, Abt said, "I observed many changes in student learning. They (students) increased their interest to learn English, minimized their stage fright, became more confident to participate in group work, more engaged in the teaching-learning process and more encouraged to ask/answer questions."

Students Taught by PSTs

Students in the classes taught by PSTs also disclosed that they improved their interest and involvement in language learning activities as the result of the change in their teachers' CLT practice after the teachers' participation in the CPDP. The students appreciated the new engaging and interactive learning tasks. *After the CDPD*, all students in this group clarified that they increased their contribution to the lessons supported by students' real-life experiences and learned listening skills using audio texts. They added that their teachers treated language learning errors in encouraging ways. Students of Tat and Mag also reported being encouraged to actively participate in various learning tasks, having lesson objectives communicated at the start of each lesson, being taught grammar and vocabulary in context, and being assessed by formative assessment techniques (e.g., quizzes, assignments, observations, class work). The students appreciated these new learning activities and their teachers' efforts to facilitate such communicative tasks. One of Tat's students expressed his appreciation of his teacher's new practices as follows, "*Frankly speaking, I like the interactive activities such as debate and role play that our teacher uses in his lessons. I also appreciate his efforts to encourage everybody to participate in the activities.*" Nevertheless, Dab's students doubted if there was any improvement in their involvement in the teaching-learning process after the intervention. Moreover, they revealed that objectives were not communicated, that grammar and vocabulary were not learned in context, and that they were not assessed by formative assessment techniques. One of his students said, "*I feel that there are changes in his teaching, but I am not sure whether he increased student involvement in the lessons after our last discussion. He usually misses classes and always rushes to cover the course contents.*"

Most positive student learning experiences were verified by their respective teachers. For instance, Mag articulated a change in his students' learning experience as follows, "*My students were quite interested and actively participated in my listening lesson supported by audio texts. I found such texts more motivating for students than teacher-read texts*." Despite the validation of students' positive learning experiences, the teachers also expressed some concerns with using CLT properly in their teaching, for instance, limited participation by some students in the communicative tasks. Regarding the issue of limited participation of students, Tat stated, *"There are still students who remain passive in the classroom most probably because of their low language ability."*

Teacher Learning Gains

FSTs' CLT Learning Gains

All FSTs reported learning gains from CLT implementation. All of the teachers indicated that CLT implementation enriched the knowledge and beliefs acquired during the seminar or during their pre-teaching education. During CLT implementation, the teachers indicated learning about communication of lesson objectives to students, integration of all skills in teaching the English language and about the importance of using audio text to teach listening. They also became more familiar with the three main stages of teaching reading and listening skills and specific activities undertaken at each stage. The teachers attributed their learning to various experiences during the implementation: facilitator feedback, new student behaviors, use of the teacher guide, their own teaching practice, and self and collaborative reflection on the facilitator's feedback. Dam, for instance, explained his CLT learning gain attributed to his facilitator's feedback as follows: "*During one of my writing lessons, I forgot to communicate objectives. After the lesson, my facilitator commented to me about the importance of communicating them. The comment taught me a good lesson and encouraged me to communicate them during the subsequent lessons."* Ascribing his learning gain to his facilitator's feedback and subsequent reflection, Abt described it as follows: "*My facilitator's feedback on a reading passage lesson, followed by collaborative reflection on the feedback strengthened my knowledge of the stages of a reading lesson. I realized using realistic experiences during the pre-reading stage is quite vital to grab students' attention."* Table 12.4 gives details about individual learning gains and attributions.

In addition, from their facilitator's feedback and the teachers' personal reflection on the feedback, the teachers indicated having learned about the use of authentic materials and experiences in making student learning meaningful (Abt and Dam), about providing chances for students to practice and use language items (Abt and Hah) and about treatment of student language errors during a communicative lesson (Dam and Hah). Hah reported her learning as follows: "*After observing one of my listening lessons, my facilitator commented that I should avoid overcorrection of students' errors to encourage them to communicate freely. After reflecting on the feedback, I learned well how to treat students' language learning errors.*"

As a result of the students' increased motivation to learn English in a communicative way, the teachers expressed their interest in continuing to learn about CLT to

Table 12.4 FSTs' learning gains and source of learning (from interview & questionnaire)

Learned CLT features and related issues	Teachers (pseudonyms)		
	Abt	Dam	Hah
Enrichment of CLT knowledge/belief	Facilitator feedback, reflection, hand-out reading	Facilitator feedback, reflection, hand-out reading	Facilitator feedback
Use of authentic materials and experiences	Facilitator feedback + self-reflection	Facilitator feedback	
Provision of chances for students to practice and use language items	Facilitator feedback, reflection		Facilitator feedback, reflection
Communication of lesson objectives	Facilitator feedback	Facilitator feedback, teacher guide	Facilitator feedback, teacher guide
Contextualization of grammar and vocabulary teaching	Own practice		
Integration of assessment with language teaching			Facilitator feedback + reflection
Integration of language skills	Own practice	Facilitator feedback, own practice	Facilitator feedback, reflection
Treatment of students' language errors		Facilitator feedback, self-reflection	Facilitator feedback, self-reflection
Use of audio text to teach listening	Facilitator feedback, collaborative reflection	Facilitator feedback, collaborative reflection	Facilitator feedback, collaborative reflection
Stages of teaching listening/reading skill	Facilitator feedback, self-reflection	Facilitator feedback, own practice	Facilitator feedback, own practice, collaborative reflection

improve how they practiced it. They said that as a result of noticing new learning behaviors by the students, they increased their confidence and satisfaction with teaching English and enhanced their self-efficacy. AbT explained his learning from changes in students' learning behaviors as follows, "*After noticing students' new learning behaviors, I improved my interaction with students, increased my confidence and satisfaction with teaching and boosted my interest to collaborate with my colleagues. I also want to continue learning about CLT and improving its practice.*"

PSTs' CLT Learning Gains

As seen in Table 12.5, PSTs reported that they achieved useful learning gains from various components of CLT implementation, particularly from their collaborative sharing, use of the teacher guide, their own teaching practice, students' new

Table 12.5 PSTs' learning gains and source of learning (From interview & questionnaire)

CLT features and related aspects	Teachers (pseudonyms)		
	Dab	Tat	Mag
Enrichment of CLT knowledge/belief	Collaborative sharing with peer, peer feedback, personal reflection	Collaborative sharing with peer, peer feedback, students new reactions	Peer feedback + own practice
Use of authentic materials and experiences	Own practice		Own practice
Provision of chances for students to practice and use language items			Students' behavior
Communication of lesson objectives	Teacher guide	Own practice	
Contextualization of grammar and vocabulary teaching	Peer feedback, own practice		
Integration of assessment with language teaching		Own practice, teacher guide	
Treatment of students' language errors	Peer feedback		Peer feedback
Use of audio text to teach listening	Peer feedback, teacher guide	Peer feedback, student reactions, teacher guide	Peer feedback, teacher guide
Stages of teaching listening/reading skill	Peer feedback, collaborative reflection	Peer feedback, collaborative reflection	Peer feedback, collaborative reflection

reactions, and from peers' feedback followed by individual or collaborative reflection on the feedback. All of them clarified that they were able to enrich their knowledge of CLT from collaborative sharing with their peers (Dab and Tat), peer feedback on their lesson enactment (all), personal reflection on the feedback (Dab), students' new behaviors (Tat), and from his own teaching practice (Mag). Tat explained his learning from new student reactions as follows: "*The active involvement of the majority of students in their lessons inspired me to know more about CLT and practice it in better ways in my teaching. It also improved my confidence for teaching English and promoted my self-esteem.*" Moreover, attributing their learning to the teacher guide and their own teaching practice, respectively, Dab and Tat reported achieving useful changes in knowledge and belief concerning the significance of communicating lesson objectives at the start of a lesson.

Furthermore, all of the PSTs reported that as the result of their being exposed to various elements of CLT implementation, they recognized the advantages of using audio texts to teach listening skill and became more familiar with the three main stages of teaching listening/reading skills in a communicative way and the activities accomplished at each stage of teaching these skills. All of the teachers attributed their learning gains regarding the use of audio texts to peer feedback and use of the teacher guide that assisted their teaching. Tat said that his students' new reactions also contributed to his learning about the issue. Again, all of them responded that their learning about the stages of teaching listening and reading skills emerged from peer feedback and personal reflections on that feedback. Mag explained his learning gain about the stages from various sources as follows: "*After teaching reading comprehension, receiving useful feedback from my peer and collaboratively reflecting on the feedback, I enriched my understanding of the three stages (pre, while and post reading) of teaching reading skills.*"

Still more, PSTs expressed that after noticing encouraging changes in student learning behaviors, the teachers were motivated to continue learning about CLT and improve their practice of it. "*The active involvement of the majority of students in their lessons inspired me to learn more about CLT and practice it in my teaching in better ways. It also improved my confidence for teaching English, promoted my self-esteem"* said Tat.

Conclusions and Discussions

This study investigated the effects of facilitator and peer support on English language CLT teaching practice, student motivation and participation, and teacher learning. Teachers' teaching practice, their students' learning, and teachers' self-reported learning were considered to be indicators for teacher learning of CLT (Guskey, 2000).

This study showed that, according to students, the CLT practice of FSTs and PSTs improved after CLT implementation. Both teacher groups applied students' authentic materials and experiences in their teaching, and used audio materials to teach listening lessons. FSTs also provided chances for students to practice and use the new language items in the classroom, and communicated lesson objectives to students at the start of each lesson. PSTs, on their part, tolerated students' language learning errors. PSTs gained significantly more from the intervention than FSTs as far as *general CLT practice*. The difference between FSTs and PSTs might be explained by the reduced psychological stress and the collaborative working environment PSTs experienced during their classroom observation, provision of feedback and reflection. Supporting this view, Joyce and Showers (2002) argued that peer coaching when provided with appropriate support and specific feedback on instructional practices enables the coached teachers to experience significant positive changes in their knowledge and practices. It allows the coached teachers to gain knowledge from trusted peers, receive constructive and nonthreatening feedback on their teaching practices and thereby expand their teaching repertoires, and reduces their sense of isolation (cf. Richards & Farrell, 2005; Thorn et al., 2007). The professional status gap between the facilitators and FSTs might have restricted the FSTs from optimally benefiting from the professional support of the facilitators.

This study also showed that after the intervention, students of both teacher groups increased their motivation to learn English and their involvement in the teaching-learning process, and appreciated and carried out more communicative tasks facilitated by their teachers than before the intervention. These student learning experiences again increased the teachers' interest in and confidence for teaching English, enhanced their self-esteem and inspired them to continue to learn about CLT and to further improve their practice of it. This might further favorably affect the teachers' CLT knowledge and beliefs, as Guskey (2000) and Loucks-Horsley et al. (2010) have indicated that improved student learning outcomes have powerful effects not only on aspects of student learning, but also on teachers' knowledge, beliefs, attitudes and classroom experiences.

From teachers' self-reported data on their learning, a significant positive influence of the intervention on PSTs' beliefs was found, but not on the beliefs of FSTs. This result agrees with the student report that PSTs had more gains in CLT practice than FSTs did. However, FSTs reported a gain in their knowledge and skills about CLT practice. A reason for the latter finding might be PSTs' overestimation of their CLT practice *before intervention*, as their large mean values on the pre-test suggest. Teacher interviews revealed that the teachers in both groups experienced important learning gains from CLT implementation: enrichment of their knowledge and beliefs about CLT and its features; identification of the advantages of using audio texts to teach listening skills, and familiarity with the three main stages of teaching listening/reading skills in a communicative way. The groups mainly attributed their learning gains to facilitators'/peers' feedback and individual or collaborative reflections on the feedback, their collaborative sharing, use of the teacher guide and their own teaching practice. Studies by Fiszer (2004) and Harmer (2007) pointed out that feedback on and reflective discussion of teaching performance, where teachers challenge each other's' ideas, clarify their views and expose their beliefs for deep and critical analysis are important sources of teacher learning. The qualitative findings for FSTs and PSTs regarding their CLT learning tended to be more comparable than the quantitative outcomes suggested.

In this study, we consider the results regarding changes in teacher classroom practice as a more reliable indicator for teacher learning than teachers' self-reported changes in student and teacher learning, because teacher practice data were provided by external sources. Accordingly, after CLT implementation, although both teacher groups reported benefiting from the intervention, students showed that PSTs have larger gains in general CLT practice than FSTs. In spite of the promising gains in CLT practice by FSTs and PSTs, three areas need specific attention. First, most teachers were found to be challenged to actively involve students in their lessons. The challenge could be attributed to the students' inadequate English ability, the way they were taught English at lower levels, and the cultural traditions of Ethiopia (Lakachew, 2003). The English language proficiency students develop at the lower grades is insufficient for practicing English communication in their classes. Grammar teaching and learning are emphasized. Moreover, Ethiopian cultural traditions and values do not encourage (especially youngsters) speaking in front of others. This might discourage the students from expressing their ideas in front of their classmates. Second, the majority of the teachers were found not to contextualize grammar and vocabulary instruction in their teaching practice. The challenge could arise from the complex nature of this CLT feature, which therefore needs extended time to learn and properly use it in communicative lessons (Richards, 2006). Third, limited interest in participating in the professional development intervention and in practicing its ideas, on the part of some teachers, could be another factor restricting the teachers from setting up and using more communicative tasks that inspire their students to actively engage in the tasks. Al-Mekhlafi and Ramani (2011), Cherkowski (2012), and Guskey (2000) asserted that teacher attitudes play a vital role in determining teacher learning of innovative instructional approaches and implementation of them in classroom teaching practices.

Although students' quantitative data showed that PSTs had larger gains in CLT practice than FSTs, data obtained from peers and facilitators could not provide clear evidence to substantiate the difference. The disagreement between student data and peer/facilitator data might be due to the limited number of classroom observations conducted by facilitators or peers. Facilitators and peers could not possibly obtain adequate information to validate all student data about the teachers' CLT practice. Contrary to the reported practice difference between the teacher groups, empirical studies (Guskey, 2000; Hord, 2004; Loucks-Horsley et al., 2010; Richards & Farrell, 2005) have shown that both forms of support play vital roles in improving classroom practice of innovative instructional approaches such as CLT. The strategies bring teachers together to interact and share their ideas and expertise, and to discuss professional problems and concerns (Richards & Farrell, 2005).

This study has implications for Ethiopian higher education, where the culture of action-based in-service professional development is almost non-existent. It demonstrates that professional development arrangements in which teachers collaborate with their peers or facilitators to enact innovative teaching approaches (such as CLT), to receive and provide feedback on their enactment and to reflect on the feedback has promise for Ethiopian higher education. In arranging such professional development, peer support appears to be more effective, sustainable, cheaper, and promotes a culture of collaboration among teachers (Fullan, 2007). The study further suggests that a professional development initiative for enhancing understanding and class use of CLT should pay due attention to teacher attitude and contextual factors, including cultural traditions of the country. Finally, for the intervention to function properly as far as continuing to enhancing English language teachers' CLT learning and implementation, further studies should address the feasibility of sustainably integrating peer support in such collaborative in-service professional development arrangements in Ethiopian higher education context.

References

Al-Mekhlafi, A., & Ramani, P. N. (2011). Expectation versus reality: Communicative approach to EFL teaching. *Studies in Learning, Evaluation, Innovation and Development, 8*(1), 98–113.

Anto, A. G., Coenders, F., & Voogt, J. (2012). Assessing the current implementation of communicative language teaching for English language teachers in Ethiopian universities. *Staff and Educational Development International, 16*(1), 51–69.

Austin, A. E. (2002). Academic staff in times of transformation: Role, challenges and professional development needs. In D. W. Chapman & A. E. Austin (Eds.), *Higher education in the developing world: Changing contexts and institutional response* (pp. 233–250). London: Greenwood Press.

Cherkowski, S. (2012). Teacher commitment in sustainable learning communities: A new 'ancient' story of educational leadership. *Canadian Journal of Education, 35*(1), 56–68.

Fiszer, E. P. (2004). *How teachers learn best: An ongoing professional development model*. Lanham, MD: Scarecrow Education.

Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Galbraith, P., & Anstrom, K. (1995). Peer coaching: An effective staff development model for educators of linguistically and culturally diverse students. *Directions in Language Education*, *1*(3). Retrieved October 31, 2012, from http://www.ncela.gwu.edu/pubs/directions/03.htm

Gray, C., & Klapper, J. (2009). Key aspects of teaching and learning in languages. In H. Fry, S. Ketteridge, & S. Marshal (Eds.), *A handbook for teaching and learning in higher education: Enhancing academic practice* (3rd ed., pp. 110–165). New York: Routledge.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Harmer, J. (2007). *The practice of English language teaching* (4th ed.). Essex, UK: Pearson Education Limited.

Hord, S. M. (2004). Professional learning communities: An overview. In S. M. Hord (Ed.), *Learning together, leading together: Changing schools through professional learning communities* (pp. 5–14). New York: Teachers College, Columbia University.

Joyce, B. R., & Showers, B. (2002). *Student achievement through staff development* (3rd ed.). Alexandria, VA: ASCD.

Kahsay, M. N. (2012). *Quality and quality assurance in Ethiopian higher education: Critical issues and practical implications*. Doctoral Dissertation. Enschede, The Netherlands: University of Twente.

Lakachew, M. (2003). *Teachers' attitudes towards communicative language teaching and practical problems in its implementation* (MA thesis). Addis Ababa, Ethiopia: Addis Ababa University.

Lieberman, A., & Mace, D. H. P. (2009). The role of 'accomplished teachers' in professional learning communities: Uncovering practice and enabling leadership. *Teachers and Teaching: Theory and Practice, 15*(4), 459–470.

Lieberman, A., & Miller, L. (2004). *Teacher leadership*. San Francisco: Jossey-Bass.

Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. (2010). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press.

Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed.). London: Sage Publications.

MoE. (2005). *Improving English language in Ethiopia: Guidelines for English language enhancement in our teacher education institutions*. Addis Ababa, Ethiopia: English Language Improvement Program (ELIP).

Richards, J. C. (2006). *Communicative language teaching today*. Cambridge, UK: Cambridge University Press.

Richards, J. C., & Farrell, T. S. (2005). *Professional development for language teachers: Strategies for teacher learning*. New York: Cambridge University Press.

Thorn, A., McLeod, M., & Goldsmith, M. (2007). Peer coaching overview. Retrieved October 31, 2012, from http://www.marshallgoldsmithlibrary.com/docs/articles/Peer-Coaching-Overview.pdf

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: A typology and a review of the literature. *Higher Education, 32*, 321–345.

Triple Creek Associates. (2007). *Benefits of mentoring*. Retrieved October 31, 2012, from http://www.3creek.com/booklets/BenefitsBooklet.pdf

Tsai, T. H. (2007). *Taiwanese educators' perspective on the implementation of the new English education policy.* Doctoral dissertation. Alhambra, CA: Alliant International University.

Ur, P. (2003). *A course in language teaching: Practice and theory*. Cambridge, MA: Cambridge Publishing Press.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Part IV
Impact on Students, Teachers and Institutional Practices: Editorial Introduction

Curriculum Design: Impact on Students, Teachers, and Institutions

In the first section of this book, we introduced teachers' learning and professional development as a result of their involvement in curriculum design. In the current section we address the impact of teachers' professional development in teacher teams on students' learning and on institutional practices. The context and culture of the cases discussed in the chapters that follow is quite diverse: higher education in Ethiopia, open higher education in Tanzania, and three studies on university education and training in Ghana. Different methods, quantitative and qualitative, are applied to determine effects on learning.

The first chapter by Anto Arkato Gendole and Fer Coenders discusses changes in teacher and student learning in the context of collaborative teacher professional development. It documents teacher learning from a 12-week collaborative professional development program (CPDP) at an Ethiopian university. Four teachers, supported by two facilitators, learned about and implemented communicative language teaching (CLT) in their teaching of English. A case study using individual teachers as units of analysis and cross-case design was applied. Both qualitative and quantitative research techniques were used. The study showed that a seminar where a CLT hand-out and a teachers' guide was presented and explained, and micro-lessons were used to practice, resulted in increased CLT knowledge and positive changes in beliefs. Consequently, the teachers improved their CLT classroom practices. These practices also seemed to favourably influence students' learning experiences.

The potential of collaborative course design in promoting instructors' professional development in relation to e-learning implementation and subsequent improvement of students' academic outcomes is widely reported. However, efforts to harness such potential in sub-Sahara Africa's universities have been insufficient. The study reported in the second chapter by Kassimu Nihuka examines the impact of collaborative course design on instructors' instructional practices and students' academic outcomes in the context of a distance education institution in Tanzania.

Results showed that collaborative course design (i) contributed to instructors' preparedness for course design and delivery using e-learning technologies and (ii) improved instructors' instructional practice. On the part of students, results indicated that a majority of students were satisfied with their experience with the courses because e-learning delivery addressed the challenges of print-based delivery and had a positive impact on their academic outcomes.

Ghanaian polytechnics were designed to equip students with competencies that make them easily employable or allow them to set-up their own businesses. In order to fulfill this mission, the studies reported in the third chapter by Edward Akomaning aimed at improving internship practices at the Department of Hotel Catering and Institution Management of Tamale and Takoradi Polytechnics by engaging teachers in the collaborative design of curriculum materials used in student internships. Results revealed that teachers appreciated being involved in collaborative curriculum design, but some regretted not being able to supervise students during their internships. Internship practices improved, and interns received the cooperation of industry. Moreover, self-assessment reports reveal that interns improved their competencies significantly compared to those students who did not go through internship.

An important challenge for Technical Vocational Education and Training is to regularly renew the curriculum in order to comply with developments in industry. The fourth chapter in this section by Marie Bakah traces the professional development of polytechnic teachers who were involved in design teams that aimed to update their courses based on recent developments in industry. The professional development of six teachers (two from each design team) was traced using Clarke and Hollingsworth's Interconnected Model of Professional Growth (IMPG). Analysis of interview data revealed that the teachers' professional growth was facilitated by engagement in curriculum design and classroom implementation. The IMPG helped unearth in-depth understanding of teacher learning and change; it provided an analytical lens into the intertwined changes in the individual teachers' knowledge and the sensitivity of these changes to complex interactions with content and teaching.

The fifth and final chapter in this section by Douglas Agyei addresses the process of curriculum reform from pilot studies to full curriculum integration. The new curriculum in mathematics for senior high school in Ghana encourages teachers to make use of the calculator and the computer for problem solving and investigations of real life situations. The goal is to help students acquire the habit of analytical thinking and the capacity to apply knowledge in solving practical problems. As a result, the government and other institutions have invested huge sums of money in procurements of computers and establishment of computer labs in most senior high schools; however, there still exists a gap between this new concept of teaching with ICT as specified in curriculum and policy documents and the use of ICT in practice. Important questions such as "what can teachers do with computers to extend instructional methods and improve students' outcomes?" remain unanswered. This chapter describes three iterations of an instructional course for pre-service mathematics teachers in Ghana aimed at addressing these types of question. The course design was based on Technological Pedagogical Content Knowledge as a conceptual framework for the course content and Learning Technology by Design as the course method. The chapter shows how evaluations informed the design of successive iterations, and proposes a set of guidelines for design of similar courses in similar contexts.

Chapter 13
Teacher Learning in Collaborative Professional Development: Changes in Teacher and Student Practices

Arkato Gendole Anto and Fer Coenders

Introduction

In Ethiopia, as in many other African countries, English serves as a medium of instruction at the secondary and higher education levels. However, the quality of the English teaching at these levels has been challenged (MoE, 2005) by various factors. The rapid and massive educational expansion in higher education is one crucial factor (MoE, 2010). The number of public universities has risen from 2 in 1994 to 31 at present. This has resulted in a dramatic increase in student enrolment, while the number of academic staff at the MA and PhD levels has failed to grow proportionally. This situation has prompted universities to recruit many under-qualified teachers at a bachelor's degree level, who have little or no pre-service teacher education or prior teaching experience. Running the universities' teaching services with such under-qualified teachers is believed to negatively affect students' English language learning (HERQA, 2008). Another challenge the universities face regarding English language teaching is moving teachers away from predominantly using teacher-dominated language *teaching* to interactive student-centred language *learning,* focusing on the use of the language for common communicative purposes. To address these challenges, support for English language teachers has been proposed, involving a collaborative professional development program (CPDP) focused on communicative language teaching (CLT), an effective language teaching approach (Harmer, 2007; Ur, 2003).

A. G. Anto
School of Graduate Studies, Arba Minch University, Arba Minch, Ethiopia

F. Coenders (✉)
Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands
e-mail: f.g.m.coenders@utwente.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_13

To guide the design and development of the CPDP, a context and needs study was conducted to assess English language teachers' current status regarding CLT use and to identify their learning needs (Anto, Coenders, & Voogt, 2012). Based on the findings of this study and a literature review, the following six design guidelines characterizing qualities of effective professional development (Austin, 2002; Loucks-Horsley, Hewson, Love, & Stiles, 2010) were generated and used to design and develop a CPDP. The guidelines include:

1. Set up an in-service professional development program that enhances the teachers' ongoing workplace CLT learning and enables them to use this kind of learning sustainably in their actual teaching practice (Harmer, 2007; Ur, 2003).
2. Peer collaboration has a central position in the design, development and implementation of the professional development program, as it promotes teacher learning through collegial sharing, reflective discussion, collaborative design of and practicing with curricular materials and provision of feedback (Austin, 2002; Harmer, 2007; Hord, 2004; Little, 1990).
3. Teachers with good teaching experience and preparation in CLT are provided with training to assume teacher leadership roles as facilitators in the CPDP (Fiszer, 2004; Guskey, 2000; Harrison & Killion, 2007; Lieberman & Miller, 2004).
4. Teacher guides are considered important tools to foster teacher professional learning (Ottevanger, 2001) and therefore to enhance curriculum implementation (Richards & Farrell 2005; Van den Akker, 1988). Collaborative design of exemplary lessons as part of the teacher guide helps teachers collectively interact with CLT content to better understand the innovation and to facilitate lesson enactment (Garet, Porter, Desimone, Birman, & Yoon, 2001; Voogt, 2010).
5. Separate workshops are organized for facilitators and teachers to prepare the facilitators for teacher leadership roles and to introduce the teachers to the essentials of CLT (Joyce & Showers, 2002; Sparks, 1997).
6. Listening skill is given considerable attention in the program, as it was rated as the most difficult skill to teach when using the CLT approach by the largest number of teachers (Anto et al., 2012).

The Interconnected Model of Professional Growth (IMPG) developed by Clarke and Hollingsworth (2002) was used to frame the study. In the next sections, the professional development program (CPDP) and IMPG are briefly described.

Collaborative Professional Development Program

CPDP has three main components: a seminar (24 h), followed by CLT implementation in class (8 weeks) and finally an evaluative workshop (4 h). The aim of the seminar (consisting of eight 3-h workshops) was to introduce the teachers to the main ideas of CLT, and to prepare them for using these ideas in their teaching practice. Joyce and Showers (2002) argued that explanation of theory and demonstration of skills in a training setting foster participants' understanding of the theory and increase their knowledge and skills. During the workshops, teachers were provided with a hand-out on *essentials of CLT*. They were also offered training on the essentials by an expert in English language teaching, supported by facilitators and the researcher. The training included presentations of CLT content, group discussions, collaborative design of teacher guides, and presentation of these guides for some lessons in the course they taught, *Communicative English Skills*, as well as practice of the lessons supported by the teacher guides and general reflections on group presentations and lesson practice.

During CLT implementation in class, the teachers, in pairs supported by facilitators, used CLT ideas in their teaching of *Communicative English Skills*. Workplace coaching allowed teachers to master and implement new skills in their instruction (Joyce & Showers, 2002). The teachers also used the teacher guides to support their actual lesson enactment, as the guides enhanced successful implementation of innovative instructional approaches such as CLT (Ottevanger, 2001; Voogt, 2010; Voogt, Tilya, & Van den Akker, 2009). The facilitators observed three lessons taught by each teacher and provided feedback. During the evaluative workshop, the participants collectively reflected on the teachers' CLT implementation experiences.

Interconnected Model of Professional Growth (IMPG)

Clarke and Hollingsworth (2002) described learning outcomes from teacher professional development in terms of change. Changes are realized in knowledge and skills, beliefs and attitudes, classroom practice and student learning behaviors (August & Shanahan 2006; Clarke & Hollingsworth, 2002; Guskey, 2000). Organizing professional learning opportunities that introduce teachers to new approaches to teaching and learning such as CLT requires consideration of teachers' knowledge, beliefs and attitudes (Guskey, 2000; Joyce & Showers, 2002; Loucks-Horsley et al., 2010). Guskey (2000) argued that teacher knowledge and beliefs are situated and affected by the teacher's experiences in the classroom. Improved student learning outcomes are also often taken as the ultimate goal of teacher professional development efforts (Clarke & Hollingsworth, 2002; Guskey, 2000; Harris & Muijs, 2005).

IMPG (Clarke & Hollingsworth, 2002) is an empirically grounded non-linear model consisting of four change domains and two mediating processes, enactment and reflection, interlinking the four domains. The domains include: *the personal domain (PD)*, representing teachers' knowledge, beliefs and attitudes; *the domain of practice (DP)*, consisting of all forms of professional experimentation; the *domain of consequence (DC),* referring to the salient student learning outcomes; and the *external domain (ED)*, dealing with external sources of information/stimulus. In this model, change in one domain triggers and affects change in another through the mediating processes of reflection and enactment. In the current study,

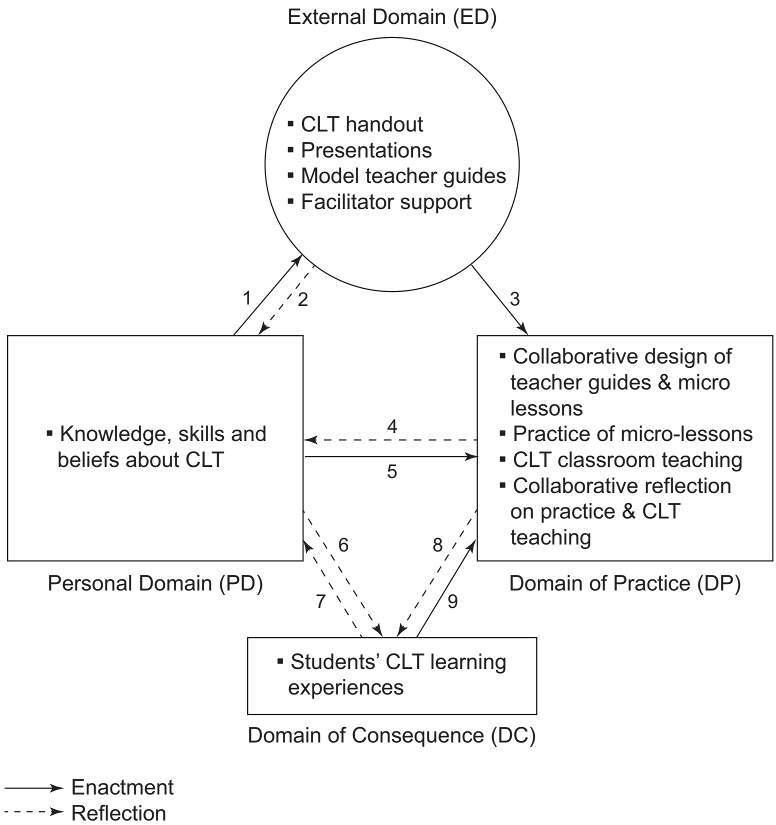


Fig. 13.1 The interconnected model of professional growth (Clarke & Hollingsworth, 2002) as used in this study

the model is used to explore teacher learning in the CPDP. The constituents of the four domains of the model in our CPDP context are presented next (see Fig. 13.1).

External domain: this represents external inputs offered to teachers in the form of a CLT hand-out, a resource person's presentations and explanations of CLT content, model teacher guides, and facilitator support made available during the seminar and suggestions during CLT implementation.

Domain of practice: this includes the collaborative design of teacher guides and practice CLT teaching in micro-lessons during the seminar, as these collective design and practice activities help the teachers interact with CLT content in order to better understand it. This domain also involves actual classroom teaching of *Communicative English Skills* lessons during CLT implementation and collaborative reflections conducted on the actual teaching of the course and on the micro-lesson practice. The domain further consists of experiences shared and reflections about CLT implementation during the evaluative workshop.

Consequence domain: this includes students' learning experiences as a result of teachers practicing CLT in *Communicative English Skills. Student learning* in this study refers to their *increased motivation to learn the English language* and their *increased participation in the teaching-learning process*; we did not collect data on improved language skills, because achieving this would require an extended period of time.

Personal domain: This encompasses teachers' CLT-related knowledge and beliefs, as well as any changes occurring due to participation in the CPDP.

The purpose of this study is to assess changes in English language teachers' CLT practices (DP), the teachers' changes in knowledge and beliefs (PD) and changes in student learning (DC). In reporting the results, changes in the domain of practice are considered more reliable than changes in teacher learning in the personal domain, because most of the data on changes in teacher practice were provided by external sources, compared to teachers' self-report data to determine changes in the personal domain. Teachers' self-report data about their learning gains were used to validate changes in teacher practice. The following general question was posed to guide the study:

> What are the effects of the CPDP on English language teachers' CLT beliefs, knowledge and practices and on student learning?

The following sub-questions were formulated:

1. *How did the classroom teaching practices of English language teachers change as the result of their participation in the CPDP?*
2. *How did the CPDP affect student learning experiences?*
3. *What learning gains (changes in CLT-related knowledge and beliefs) are reported by the teachers? And what components of the intervention contributed to these learning gains?*
4. *What environmental factors facilitated or constrained teachers' learning?*

Methods

Design

A case study design (Yin, 2003) using individual teachers (N = 4) as units of analysis was applied to study teachers' learning. To understand similarities and differences in patterns (Miles & Huberman, 1994) of CLT learning and implementation among the teachers, a cross-case design was used to frame the results of the study.

Table 13.1 Teachers' background information

Facilitator name	Teacher name	Sex	Age	Teaching experience	Qualification	Previous CLT training
Dagi[a]	Aman[a]	M	20	1 year	BA in English	No
	Tola[a]	M	28	3 years	B. Ed in English teaching	Yes
Bini[a]	Shire[a]	M	21	1 year	BA in English	No
	Kara[a]	M	26	3 years	B. Ed in English teaching	Yes

[a]Pseudonyms

Participants

Facilitators, teachers and students participated in the study (see Table 13.1). Two male teachers (whom we call Dagi and Bini) were deliberately selected as facilitators, in consultation with the department head, for their good professional competences and reputation among the staff (Lieberman & Mace, 2009; Lieberman & Miller, 2004). Both of the facilitators held an MA in teaching English as a foreign language (TEFL). Four male teachers (who worked in two teams) took part in the program. Two of them (Aman and Shire) had a bachelor's degree in applied English, and they did not take any courses on CLT before they started teaching. Both of them had 1 year of teaching experience. Tola and Kara had a bachelor's degree in teaching English and took some courses on CLT before they started teaching. Both of them had 3 years of teaching experience. Throughout the program, Aman and Tola were supported by Dagi, and Shire and Kara by Bini. All the teachers were teaching *Communicative English Skills* at the time the program was piloted.

One-third of the students from each of the four classes in which the teachers taught *Communicative English Skills* were randomly selected to complete pre- and post-seminar questionnaires on their teachers' CLT practices. In consultation with their respective teachers, 16 other students were purposefully selected (4 students from each class) for focus group discussions about the teachers' CLT practices and students' learning experiences. Students of Aman and Shire (teachers with no CLT training) were assigned to group I, and students of Tola and Kara (teachers with CLT training before they started teaching) were made group II. Students of teachers with similar educational background were put into the same focus group because it was thought that their teachers' performance would look more similar than the performance of teachers in the other group. This would enhance drawing similar conclusions from each student group's discussion.

Instruments

Interviews, questionnaires, observations and focus group discussions were used to collect data. Teachers were interviewed on three occasions: (a) *before the intervention*, to gather information on teachers' initial knowledge, beliefs and practices related to CLT; (b) *after the seminar*, to examine changes in teachers' CLT-related knowledge, belief and practices resulting from the seminar workshops, as well as factors enhancing or hindering teacher learning during the seminar; and (c) *at the end of the intervention,* to identify changes in teachers' CLT-related knowledge, belief and practices resulting from CLT implementation and the evaluative workshop; factors enhancing or hindering teacher learning from CLT implementation; and changes in student learning. Similar data were collected by teacher questionnaires at various stages of the program for validation purposes. Class observation was used to obtain data on the teachers' CLT classroom implementation and to validate what teachers reported having learned. Further, a student questionnaire was administered and focus group discussions were organized before and after the intervention to secure information on teachers' initial and final CLT practices. The focus group discussions were also used to gather information on student learning experiences resulting from their teachers' new teaching approach. Table 13.2 shows the relationship between the research questions and the data collection instruments.

Data Analysis

A mixed methods approach with both quantitative and qualitative techniques was used to analyze the data. For the quantitative analysis, descriptive statistics including means and standard deviations were used. Mann Whitney *U* non-parametric analysis was used to determine whether the CPDP intervention made any significant contributions to individual teachers' CLT practice as perceived by students. Cohen's *d* was calculated to measure the effect size of the intervention. The qualitative data collected via interviews were transcribed, coded, transported into Atlas.ti (Version 6.2), and analyzed using thematic codes generated from the data. Interview quotations from two teachers were randomly selected and recoded by another coder to determine inter-coder reliability. Agreement was computed to be outstanding (Cohen's $\kappa = 0.80$). The inter-rater reliability between each facilitator and the first author was also calculated for the lesson observation for one teacher. Accordingly, the inter-rater agreement between facilitator 1 and the researcher (Cohen's $\kappa = 0.63$) and between facilitator 2 and the researcher (Cohen's $\kappa = 0.62$) were found to be

Table 13.2 Relationship between research questions and data collection instruments

Specific research questions	Instruments: Teacher interview	Teacher questionnaire	Classroom observation	Student questionnaire	Focus group discussion (students)
How did the classroom teaching practices of English language teachers change as the result of their participation in the CPDP?	X	X	X	X	X
How did the CPDP affect student learning experiences?	X				X
What learning gains (CLT-related knowledge and belief changes) are reported by the teachers? And what components of the intervention contributed to these learning gains?	X	X	X		
What environmental factors facilitated or constrained teachers' learning?	X				

substantial. Moreover, the internal reliability of the items (22 items) on the students' questionnaire measuring teachers' CLT practices was computed to be excellent (Cronbach's $\alpha = 0.9$). Data obtained through focus group discussions were analyzed using a descriptive summary. In conducting the analysis, teachers' CLT practice and learning of the CLT features were emphasized.

Main Findings

Teachers' Changes in CLT Practices

In the IMPG domain of practice, students of all teachers revealed in the focus group discussions that their respective teachers made essential changes in their CLT practices after the seminar (Table 13.3).

Before the intervention, the students reported that the teachers used limited CLT features in their teaching of *Communicative English Skills*, except Tola, who had CLT training before he participated in the CPDP. The students said that all of the

Table 13.3 CLT features practiced by teachers after the intervention (which were not/rarely practiced before) as reported by students, facilitator and researcher

	Teachers			
	Aman	Tola	Shire	Kara
CLT features and related issues (PD)	*Reported after intervention by*			
Active involvement of students in teaching-learning process	Students			
	Facilitator			
	Researcher			
Use of authentic materials and experiences	Students		Students	Students
	Facilitator		Facilitator	Facilitator
	Researcher		Researcher	Researcher
Use of an integrated-skills approach to teaching of language	Facilitator			
	Researcher			
Preparation/use of lesson plans and communication of lesson objectives	Students	Students	Students	Students
	Facilitator	Facilitator	Facilitator	Facilitator
	Researcher	Researcher	Researcher	Researcher
Integration of assessment with language teaching	Facilitator			Students
Use of audio text to teach listening	Students	Students	Students	Students
	Facilitator	Facilitator	Facilitator	Facilitator
	Researcher	Researcher	Researcher	Researcher

teachers facilitated collaborative learning by their students and used English for classroom communication. All of the teachers, except Aman, usually involved students actively in the teaching and learning process. In addition, Tola used students' authentic experiences and materials in his lessons, let them use and practice the language items he taught in the classroom, and often tolerated students' language errors.

After the intervention, however, the students disclosed that all of the teachers communicated lesson objectives at the start of their lessons and taught listening lessons using audio materials they had never used before. One of Tola's students expressed Tola's change in CLT practices as follows, "*The teacher has started to do many things he did not do before. Now he communicates lesson objectives at the start of each lesson; he uses audio materials to teach listening skill. He never accomplished these activities before*." All teachers (except Tola) began to use authentic materials in their teaching. Aman was able to actively involve students in his lessons. One of his students witnessed his change in practice changes, saying, "*After our last discussion, our teacher has changed his teaching much. He often involves students in the teaching-learning process using interactive group and pair work, uses authentic materials such as newspapers and advertisements to make his lessons more meaningful and interesting*."

Mann Whitney *U* non-parametric analysis of students' pre-post questionnaire data, used to measure the teachers' use of CLT features in their teaching, confirmed that all the teachers made significant improvements in their CLT practices after participating in the CPDP, as reported by their students: Aman (n = 22, $Z = -3.7$,

$p = 0.003$, $d = 2.0$); Tola (n = 20, $Z = -2.9$, $p = 0.002$, $d = 1.2$); Shire (n = 20, $Z = -4.4$, $p = 0.003$, $d = 3.0$) and Kara (n = 15, $Z = -2.1$, $p = 0.021$, $d = 1.7$).

However, even after being exposed to the workshops, the teachers failed to implement some CLT features. None of the teachers contextualized grammar and vocabulary in their teaching. Only Aman used an integrated-skills approach in his teaching and treated his students' language errors properly. Aman and Shire did not provide chances for students to practice and use language items that had been taught in the classroom and outside the classroom for their actual communication.

Students' Change in Learning Experiences

In this section, the results are reported from pre- and post-intervention focus group discussions held with two student groups (each with eight students) formed from four classes (four students from each class). Students of Aman and Shire were assigned to group I and students of Tola and Kara made up group II. The teachers also confirmed these findings in the interviews.

From the discussions in the two student groups, it became clear that as the result of their respective teachers' changes in CLT practices, the students experienced substantial changes in their learning of *Communicative English Skills*.

Before the intervention, students stated that their respective teachers applied limited CLT features in their teaching practices and that this resulted in a limited role for students in the teaching-learning process. They revealed that they only sometimes had chances to actively participate in the teaching-learning process and do some communicative activities in groups and pairs. Students in group II said that often they were not given chances to practice the language items that had been taught (e.g., introducing oneself to others) in class, but they were usually encouraged to ask or answer questions irrespective of errors they committed. Tola's students added that every now and then they learned English using authentic materials such as newspapers. Students in both groups clarified that they never learned listening skills using audio materials.

After the intervention, however, the students in both groups explained that their respective teachers had improved their teaching of *Communicative English Skills* and therefore the students experienced improved learning. All of them reported increased involvement in the learning process. Students learned English more meaningfully, as they (1) felt supported by authentic experiences and materials such as newspapers and advertisements, (2) could more interactively participate in group and pair work, and (3) learned listening skills using audio materials. They particularly felt enthusiastic about and appreciated the use teachers made of audio materials (not used by any of the teachers before the seminar) to teach listening skills lessons. Moreover, all of them explained that as their respective teachers now often communicated the lesson objectives before commencing their lessons, the students were more attracted towards the lessons. They further stated that as the result of the teachers' improved teaching performance, the stage fright of most students during oral presentations was reduced, and their rapport with their respective teachers was enhanced. They seemed to be pleased and satisfied with the performance of their respective teachers. One of Tola's students expressed his feeling as follows,

> After our last discussion, our teacher's way of teaching has changed much, and it changed our learning behaviors as well. As he often comes to class with a bright face, we are much more motivated toward his lessons. His communication of lesson objectives at the start of each lesson grabs our attention to the lesson. We are now more involved in the lessons than we used to be; we are intensively engaged in group work. Moreover, we listen to interesting audio materials.

Teachers' Learning Gains

In terms of the IMPG change domains, while the CLT-related features and other related issues represent the personal domain, the various program experiences yielding teacher learning refer to the external domain, the domain of practice, and the consequence domain.

Teachers' Learning from the Seminar

The teachers reported that they made important learning gains during the seminar. All four teachers reported that through the seminar activities (CLT hand-out, presentations, facilitator support, collaborative design, and microteaching) they either updated or acquired new understanding of CLT and its inherent features. For instance, Aman explained his learning gain regarding CLT concepts and inherent features from CLT hand-out reading and presentations as follows, "*Before the workshop, I had little knowledge of CLT. My reading of the hand-out, the resource persons' presentations and the collaborative design activities really assisted me to understand its concepts and to grasp the main ideas of its features.*" The teachers became familiar with the lesson plan format and its content, as well as with the lesson procedures of a CLT lesson, including communicating lesson objectives. Shire expressed his learning from the collaborative design of teacher guides as follows, "*The collaborative design activities of the teacher guide helped me critically look into and understand the format, contents and implementation steps of a communicative lesson and to identify the importance of communicating lesson objectives at the start of a lesson.*"

All of the teachers (except Tola) also clarified that they learned about the use of authentic experiences and materials in students' language learning from CLT hand-out reading (Aman), presentations (Aman, Shire and Kara) and group discussions held in collaborative design teams (Shire). Aman reported about his learning in this way, "*From the presentation, explanations and hand-out reading, I understood that* *linking language teaching with student authentic experiences such as asking students to greet their classmates makes language learning interesting and meaningful to students.*" Kara also explained the use of such materials over artificial ones in language learning as follows, "*Authentic materials provide students with real language for communication whereas artificial materials require students to fabricate language for their communication. Such materials make the teaching learning process meaningful and interesting, and stimulate students to actively participate in the process.*"

Even though Aman practiced an integrated skills approach as observed by his facilitator and the researcher, he did not mention any learning gain related to this particular CLT feature (DP). Shire, on the other hand, explained that through collaboration with his fellow teacher and the facilitator, he learned how to use integrated skills to teach a language, but he was not seen integrating skills in his teaching. He explained his learning thus, "*My collaboration with Kara and the facilitator during CLT presentations and discourses enriched my understanding of CLT through experience-sharing and negotiation of the meaning of issues such as using integrated skills approach to teach a language.*" In addition, Aman, who was observed by his facilitator to integrate assessment with language teaching, disclosed that he learned this from the presentations and discussions following the presentations. He stated his learning gains as follows, "*From the presentations and collaborative group discussions, I learned that in CLT, assessment is integrated with language learning and focuses on checking students' actual language abilities using observation, portfolios, checklists, quizzes when students are performing various language learning tasks.*"

Teachers' Learning Gains from CLT Implementation and Evaluative Workshop

From their use of CLT in class and associated experiences (facilitator support and students' reactions), the teachers reported having strengthened their existing CLT-related knowledge or their knowledge gained from the seminar. All of them reported having achieved important learning gains concerning lesson planning that facilitated their understanding of various aspects of lesson objectives, and this came particularly from peer collaboration and facilitator feedback. For example, Shire explained that from planning his lessons, he learned how to state specific lesson objectives. He discussed his learning as follows, "*Preparing lesson plans enabled me to learn that specific lesson objectives need to be stated in precise terms and used with specific daily lessons.*" Tola also reported his learning regarding this point as follows, "*My facilitator's feedback on my lesson plans, and my own practical teaching experience taught me that planning a lesson is very useful to have a clear focus of lesson execution.*" In addition, he said that *"Communicating objectives at the start of a lesson is essentially helpful to catch and focus students' attention on the lesson."*

From using audio materials to teach listening skills (Aman, Tola, Kara and Shire) and from lesson execution enriched by lesson reflection (Kara), the teachers learned that using audio materials motivates students more than teacher-read texts do in teaching listening skill. Aman discussed his experience of using audio text to teach listening skill and his view about it as follows, "*I found my students more interested in listening to audio texts than listening to my reading while teaching listening skills…This convinced me that audio materials are more effective than teacher-read texts in teaching listening lessons.*" Again, Kara explained his learning from his practical teaching accompanied by reflection on the lesson in this way, "*As students did not experience such materials before, they found the lessons quite interesting and actively participated in them. After reflecting on the lesson, I realized that in teaching listening skills audio texts motivate students more than teacher-read texts do.*"

Moreover, Aman described improving his learning about actively involving students in the teaching-learning process based on his own teaching practices and from his colleague's sharing of experiences during the evaluative workshop. He expressed his learning gain from sharing experience from a colleague during the evaluative workshop as follows, *"During the workshop, a teacher shared his practical experience of moving around the class and checking each student's contribution to group work. I found it very helpful to overcome the problem of students' low involvement in group work as it encourages everybody to contribute when the teacher is around. I adopted this experience to improve student involvement in my lessons."*

All of the teachers asserted that their students felt quite delighted with the listening lessons that were conducted through audio materials, something they had never done before. All of them again validated that students increased their involvement in the learning process and their motivation to learn *Communicative English Skills*. They disclosed that the students' stage fright about making oral presentations diminished. Shire and Kara added that as the result of the change in their teaching practice, students built better rapport with them (teachers). The teachers further revealed that their reflection on the positive changes in student learning increased their self-confidence and motivated them to further strive for the improvement of their CLT-related knowledge and practical implementation of it.

Environmental Factors Facilitating or Constraining Teachers' Learning

As noted in Table 13.4, the teachers identified a variety of factors that facilitated or constrained their learning. During the workshops, all of the teachers, except Shire, mentioned the resource persons' (researcher and English expert) abilities to organize and deliver the workshop activities in attractive ways as a vital source of motivation for their learning. Aman and Tola also considered consistent cooperation from the department head to flexibly change their classes and his generous support of all seminar activities as essential factors enhancing their learning. Moreover, Shire and Kara considered the availability of such collaboration as another factor

Table 13.4 Factors facilitating or constraining teachers' learning in various components of CPDP

CPDP components	Factors facilitating or constraining learning	Aman	Tola	Shire	Kara
Seminar	Factors facilitating learning				
	Resource persons' competencies to conduct training	+	+		+
	Department head's cooperation in changing class and supporting the program	+	+	±	±
	Facilitators' strong commitment and abilities				+
	Factors constraining learning				
	Teachers' parallel involvement in teaching and training	+	+	+	
	Shortage of common time to undertake activities		+		+
	Lack of well-functioning language lab facilities		+		
CLT implementation	Factors facilitating learning				
	Working with a teacher with CLT background	+		+	
	Facilitators' strong commitment and abilities		+		+
	Consistent department head support and participation			+	
	Factors constraining learning				
	Shortage of time to implement CLT ideas	+	+	+	+
	Poor network connectivity			+	+
	Poor transportation service			+	+

promoting their learning. By contrast, the teachers' parallel involvement in teaching and seminar activities was identified by Aman, Tola and Shire as a factor impeding their learning.

During CLT implementation, the teachers indicated different external factors that promoted or hindered their learning. Aman and Shire indicated being teamed up with teachers having a background in CLT as a good source of learning. They said that such an arrangement encouraged their collaborative discussion and reflective sharing. Their facilitator's strong commitment and good facilitation competences were also noted as valuable source of learning by Tola and Kara. However, all of the teachers pointed out that they usually encountered a shortage of time to properly practice CLT ideas in their classrooms. Because of the large number of students in their classes and their students' insufficient language abilities, the teachers often needed more time to involve all students in the learning process and to provide them with chances to practice the language items that had been taught. Shire and Kara reported that poor internet and network connectivity sometimes hindered their communication with their collaborating teachers and facilitators via email and cellphone and limited their learning. They further mentioned the university's poor transportation service as another factor that limited their learning from implementation. For instance, Kara described his experience as follows, "*Once I arranged a classroom observation with my facilitator, but because of the university transportation arrangement problem, the facilitator could not come and observe my lesson at Chamo Campus.*"

Discussion and Conclusion

The purpose of this study was to explore teacher learning from the CPDP aimed at enhancing English language teachers' understanding and implementation of CLT. Clarke and Hollingsworth's (2002) IMPG was applied to frame teacher learning from the program; therefore, the discussions and conclusions of the study are presented using this model as a framework.

In the *Domain of Practice*, this study showed that after having been exposed to the CDPD, the teachers improved their classroom CLT practices, which resulted in improved student CLT learning experiences. Teachers (a) involved students more actively in the teaching-learning process than they did before and encouraged students' collaborative learning, (b) linked language teaching to student real-life experiences, (c) planned their lessons and used the plans to guide lesson implementation, (d) communicated lesson objectives at the start of their lesson delivery, and (f) taught listening lessons using audio materials, which they had never done before. The results are consistent with the results of other studies (Tellez & Waxman, 2005; Watzke, 2007) in which in-service training on content knowledge and pedagogical skills for English language teachers, followed by mentors' coaching of the teachers' classroom practices, improved the practices of the teachers.

Representing the *Consequence Domain*, the ultimate goal of a professional development initiative is improved student learning. This study demonstrated that the teachers' changed CLT practices (*Domain of Practice*) led to more positive student learning behaviors (*Consequence Domain*). The students (a) increased their involvement in the learning process, (b) were more motivated to learn and reduced their stage fright during oral presentations, (c) listened to audio materials which they had never practiced with before, and (d) strengthened positive relationships with their teachers.

In the *Personal Domain*, the teachers obtained or refreshed their *knowledge* of the concept of CLT and of its main features from presentations during the seminar and the teachers' own CLT hand-out reading. From collaborative design of teacher guides and micro-teaching, teachers became familiar with the CLT lesson plan format and CLT content and its execution procedures, and they realized that teacher collaboration enhances CLT learning and implementation. From their actual classroom teaching, supported by facilitator feedback and collaborative reflections, teachers developed their *pedagogical skills* and learned how to relate language teaching to students' real-life experiences as well as how to involve students actively in the teaching-learning process. The teachers concluded that facilitator support of different CLT learning activities enhanced their CLT learning and practice. Realizing and reflecting on students' positive reactions and considering the reactions as salient, the teachers obtained professional satisfaction from their work, boosted their self-esteem and were motivated to further improve their future CLT learning and practice. The results of this study are consistent with other studies (Tellez & Waxman, 2005; Watzke, 2007) where teachers' workplace learning accompanied by mentors' classroom observation and provision of feedback enhanced the participating teachers' subject matter knowledge, pedagogical skills and classroom teaching practices.

Again belonging to the *Domain of Practice*, after the CDPD, the participating teachers encountered challenges in implementing some CLT features, such as integrating assessment with language teaching, using an integrated skills approach in their teaching, and contextualizing grammar and vocabulary when teaching other skills. A possible reason for the teachers' difficulty in implementing these features successfully is that the features encompass broad and complex concepts in CLT, and that the teachers therefore need more intensive and extended training to clearly understand and properly implement them in their teaching. Regarding assessment, McNamara (2009) confirmed that communicative language assessment is a highly technical and complex process that demands the involvement of many skills and operates under circumstances that impose heavy practical time constraints. In order to help the teachers have more in-depth understanding of relatively less implemented CLT features, a more comprehensive in-service professional learning opportunity that intensively addresses those features should be arranged and implemented over a longer time. Moreover, in addressing lessons related to those features in *Communicative English Skills*, more practical examples of activities could be provided in the teacher guides. Our study shows that after the seminar, teachers with a CLT background applied most of CLT features better than the teachers without CLT background. This can possibly be explained by a renewal of CLT ideas for teachers having a CLT background. This renewal could promote the teachers' CLT-related understanding, leading to better CLT practices in their actual teaching.

In line with the contentions of different authors (Guskey, 2000; Loucks-Horsley et al., 2010), this study revealed that teachers' and facilitators' keen interest to participate in the program, as well as the strong commitment of the department head to support the program, were factors enhancing teacher learning. However, teachers' and facilitators' parallel involvement in teaching and training activities, and shortage of time to implement CLT ideas in their classroom teaching, were identified as factors hindering teachers' learning. Despite the reported hindering factors, it is crucial to capitalize on factors enhancing teacher learning to further investigate the potential of the CPDP in supporting larger number of teachers to learn and implement CLT in their teaching practice. Moreover, as having adequate numbers of facilitators might not always be feasible, looking for an alternative form of support for teacher professional learning opportunities appears to be essential. In further research (see Anto et al., 2012), we have explored the use of peer-support as an additional professional development strategy in learning from implementation of CLT, because Thijs and Van den Berg (2002) showed that peer support/peer coaching can be an effective strategy for promoting the professional development of teachers.

Despite the stated success of the CPDP, some challenges were encountered. First, the teachers were challenged to properly implement certain complex features of CLT: integrating assessment in language teaching, contextualizing grammar and vocabulary in their teaching practice and involving students actively in the teaching-learning process. The challenges of integrating assessment in language teaching and contextualizing grammar and vocabulary in the teaching of other skills were thought to emerge from the complex nature of these CLT features (McNamara, 2009).

Scholars such as Richards (2006) have advised providing extended time for teachers to learn and properly use the features in their communicative lessons. The challenge of actively involving students in their teaching-learning process is possibly attributable to the students' inadequate English ability, the way they were taught English at lower levels, and the cultural traditions of Ethiopia (Lakachew, 2003). Students develop insufficient English language proficiency in the lower grades to practice English communication in their classes. Grammar teaching and learning is emphasized. Moreover, Ethiopian cultural traditions and values do not encourage (especially for youngsters) speaking in front of others. This might discourage the students from expressing their ideas in front of their classmates and the teacher as well. To address the issue of involving students in the language teaching-learning process, English language teachers of primary and secondary schools should also be given appropriate training on CLT so that they are able to apply it in their teaching and offer fair attention to all language skills. In this way, students will have a chance to practice expressing themselves in English from the lower grades onwards. By the time they enroll in higher education, they will already be used to communicating their ideas in front of others. English language teachers in higher education should also be open and feel free to create a conducive learning environment and persistently encourage students to convey their thoughts in English freely both inside and outside the classroom.

Second, consistent with the view of Fullan (2007) that the introduction of educational change usually encounters resistance from the people affected, the implementation of CPDP faced resistance from a few participating teachers. The resistance became apparent through teachers' reluctance to attend training sessions and unwillingness to allow facilitators to observe the teachers' lessons. Studies by Al-Mekhlafi and Ramani (2011) and Cherkowski (2012) showed that teacher attitude plays a vital role in determining teacher learning of innovative instructional approaches and implementation of them in their classroom teaching practices. Guskey (2000) and Fullan (2007) reported that becoming a better teacher, that is, improving one's professional knowledge and skills and thereby improving student learning, is the primary motive for most teachers to participate in professional development activities. Their findings may reflect the reality of developed western countries. However, in the context of Ethiopia, where most teachers (even higher education teachers) cannot properly fulfill their basic needs with their normal salary, it is less likely that improving one's professional knowledge and skills to raise student learning outcomes becomes the top motive for teachers to participate in a professional development initiative. The teachers usually associate professional development undertakings with extrinsic rewards (external benefits) in the form of extra payment, higher salaries, or career promotions. Teachers seem to be more motivated to carry out additional part-time jobs than to participate in professional learning activities.

In the context of developing countries like Ethiopia, provision of external rewards such as financial incentives, career promotion and certificates could be useful to make the teachers part of a professional development endeavor and let them see the value of the endeavor to their professional growth.

References

Al-Mekhlafi, A., & Ramani, P. N. (2011). Expectation versus reality: Communicative approach to EFL teaching. *Studies in Learning, Evaluation, Innovation and Development, 8*(1), 98–113.

Anto, A. G., Coenders, F., & Voogt, J. (2012). Assessing the current implementation of communicative language teaching for English language teachers in Ethiopian universities. *Staff and Educational Development International, 16*(1), 51–69.

August, D., & Shanahan, T. (Eds.). (2006). *Developing literacy in second-language learners: Report of the National Literacy Panel on language-minority children and youth*. Mahwah, NJ: Lawrence Erlbaum.

Austin, A. E. (2002). Academic staff in times of transformation: Role, challenges and professional development needs. In D. W. Chapman & A. E. Austin (Eds.), *Higher education in the developing world: Changing contexts and institutional response* (pp. 233–250). London: Greenwood Press.

Cherkowski, S. (2012). Teacher commitment in sustainable learning communities: A new 'ancient' story of educational leadership. *Canadian Journal of Education, 35*(1), 56–68.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*(8), 947–967.

Fiszer, E. P. (2004). *How teachers learn best: An ongoing professional development model*. Lanham, MD: Scarecrow Education.

Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*, 915–945.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press, Inc.

Harmer, J. (2007). *The practice of English language teaching* (4th ed.). Essex, UK: Pearson Education Limited.

Harris, A., & Muijs, D. (2005). *Improving schools through teacher leadership*. Maidenhead, UK: Open University Press.

Harrison, C., & Killion, J. (2007). Teachers as leaders: Ten roles for teacher leaders. *Educational Leadership, 65*(1), 74–77.

Higher Education Relevance and Quality Agency (HERQA). (2008). *Arba Minch University quality audit report*. Addis Ababa, Ethiopia: St. George Printing Press.

Hord, S. M. (2004). Professional learning communities: An overview. In S. M. Hord (Ed.), *Learning together, leading together: Changing schools through professional learning communities* (pp. 5–14). New York: Teachers College, Columbia University.

Joyce, B. R., & Showers, B. (2002). *Student achievement through staff development* (3rd ed.). Alexandria, VA: ASCD.

Lakachew, M. (2003). *Teachers' attitudes towards communicative language teaching and practical problems in its implementation* (MA thesis). Ethiopia: Addis Ababa University.

Lieberman, A., & Mace, D. H. P. (2009). The role of 'accomplished teachers' in professional learning communities: Uncovering practice and enabling leadership. *Teachers and Teaching: Theory and Practice, 15*(4), 459–470.

Lieberman, A., & Miller, L. (2004). *Teacher leadership*. San Francisco: Jossey-Bass.

Little, J. W. (1990). The persistence of privacy: Authonomy and intiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.

Loucks-Horsley, S., Hewson, P. W., Love, N., & Stiles, K. E. (2010). *Designing professional development for teachers of science and mathematics*. Thousand Oaks, CA: Corwin Press, Inc.

McNamara, T. (2009). Principles of testing and assessment. In K. Knapp, B. Seidlhofer, & H. Widdowson (Eds.), *Handbook of foreign language communication and learning* (pp. 607–627). Berlin, Germany: Walter de Gruyter.

Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed.). London: Sage Publications.
MoE. (2005). *Education sector development program III (ESDP-III) 2005/2006–2010/2011* (studies 1 & 2; Unpublished document). Addis Ababa, Ethiopia.
MoE. (2010). *Education sector development program IV (ESDP-IV): 2010/2011–2014/2015* (Unpublished document). Addis Ababa, Ethiopia.
Ottevanger, W. (2001). *Teacher support materials as catalyst for science curriculum implementation in Nambia.* Doctoral Dissertation. Enschede, The Netherlands: University of Twente.
Richards, J. C. (2006). *Communicative language teaching today*. Cambridge, UK: Cambridge University Press.
Richards, J. C., & Farrell, T. S. (2005). *Professional development for language teachers: Strategies for teacher learning*. New York: Cambridge University Press.
Sparks, D. (1997). School reform requires a new form of staff development. In S. D. Caldwell (Ed.), *Professional development in learning-centered schools* (pp. 8–17). Oxford, UK: National Development Council.
Tellez, K., & Waxman, H. C. (2005). *Effective professional development programs for teachers of English language learners*. Philadelphia: The Laboratory for Student Success, Mid-Atlantic Regional Educational Laboratory.
Thijs, A., & Van den Berg, E. (2002). Peer coaching as part of a professional development program for science teachers in Botswana. *International Journal of Educational Development, 22*, 55–68.
Ur, P. (2003). *A course in language teaching: Practice and theory*. Cambridge, UK: Cambridge Publishing Press.
Van den Akker, J. (1988). *Ontwerp en implementatie van natuuronderwijs [design and implementation of science education]*. Lisse, The Netherlands: Swets & Zeitlinger.
Voogt, J. (2010). A blended in-service arrangement for supporting science teachers in technology integration. *Journal of Technology in Teacher Education, 18*(1), 83–109.
Voogt, J., Tilya, F., & Van den Akker, J. (2009). Science teacher learning for MBL-supported student-centered science education in the context of secondary education in Tanzania. *Journal of Science Education and Technology, 18*, 429–428.
Watzke, J. L. (2007). Foreign language pedagogical knowledge: Toward a developmental theory of beginning teacher practices. *The Modern Language Journal, 91*(1), 63–82.
Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Chapter 14
Impact of Collaborative Course Design on Instructors' Practices and Students' Academic Outcomes

Kassimu A. Nihuka

Introduction

The Open University of Tanzania (OUT) is a distance education institution that has made a significant progress towards integration of e-learning for delivering its programs and courses. When it started in the 1990s, OUT used postal services and its own transportation to reach students in regional centres at the beginning of the academic year. A study by Nihuka and Voogt (2011) conducted at OUT indicated that such a practice is associated with challenges such as delays in the delivery of course outlines and study materials, lack of regular interactions between instructors and students, delays in or lack of feedback on student learning, and feelings of isolation among students. Encouragingly, studies have shown that e-learning technologies have the potential to (i) enrich delivery of courses and learning resources (Bates, 2000; Pena-Bandalaria, 2007), (ii) facilitate access to learning resources, (iii) alleviate feelings of disconnectedness by improving interactions between instructors and students (Fozdar & Kumar, 2007; Ludwig-Hardman & Dunlap, 2003; Thomas & Carswell, 2002 and (iv) provide feedback and support to students (Ludwig-Hardman & Dunlap, 2003; Pena-Bandalaria, 2007). E-learning technologies also have the potential to improve students' academic outcomes (Bates, 2000).

Although e-learning has potential, the implementation of such technologies in most universities in sub-Saharan Africa is still very low (Hoven, 2000; Sife, Lwoga, & Sanga, 2007; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006). According to Sife et al. (2007), one of the major barriers to e-learning implementation is a lack of systematic approaches to the preparation of instructors for e-learning course design and implementation. Taking OUT as an example, instructors' preparation for the use of e-learning has been predominantly provided through workshops that have

K. A. Nihuka (✉)
Institute of Adult Education, Dar es Salaam, Tanzania
e-mail: kassimu.nihuka@iae.ac.tz

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_14

shown to be ineffective (Bakari, 2009). As a result, for many years, instructors at OUT have continued to deliver their courses using the traditional print-based mode with limited integration of e-learning technologies, despite significant investment.

An effective professional development arrangement involves instructors actively, includes reform-oriented activities that are sustained over time, and provides follow-up support and opportunity for collaboration (Desimone, Porter, Garet, Yoon, & Birman, 2002; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Simmie, 2007). Several studies have demonstrated that *collaborative course design*, as a strategy for the professional development of instructors, is effective in improving instructors' skills for e-learning course design, e-learning technology implementation, and pedagogies (Mishra, Koehler, & Zhao, 2007; Voogt, 2010).

In this study, *collaborative course design* strategy was used at OUT to prepare instructors for e-learning course design and delivery. According to Nihuka and Voogt (2011), *collaborative course design* enables instructors to transform their print-based courses into e-learning courses, which are then delivered via Moodle LMS and supported by e-mail and mobile phones. In order to investigate the impact of *collaborative course design* on instructors' practices, instructors were allowed to offer/deliver the courses to students for 12 weeks. Further, students enrolled in the courses were oriented as to how to learn in this new environment and access the courses offered in Moodle LMS. This chapter discusses results for (i) the impact of collaborative course design on instructors' instructional practices and (ii) the impact of e-learning delivery on students' academic outcomes.

E-Learning Implementation in Distance Education

Challenges of E-Learning Implementation

In most of sub-Saharan Africa's universities, the implementation of e-learning technologies to enhance distance education is limited (Dzakiria, 2004; Ludwig-Harman & Dunlap, 2003; Mcharazo & Olden, 2002. This is because most universities are confronted with challenges such as (i) perceptions about e-learning technologies (Bakari, 2009; Phillips, 2005; Siritongthaworn et al., 2006), (ii) access to infrastructure (Aguti & Fraser, 2006; Nnafie, 2002; Resta & Laferriere, 2008), (iii) narrow bandwidth (Gakio, 2006) and (iv) limited skills and competence for use of e-learning technologies on the part of both instructors and students (Hoven, 2000; Kirkwood & Price, 2005).

Instructors' perception about e-learning technologies is one of the challenges for successful e-learning implementation in distance education (Bakari, 2009; Siritongthaworn et al., 2006). According to Bakari (2009), some instructors do not perceive e-learning as an effective means for teaching and learning. The perceived benefits of a particular technology have great influence on instructors' decision on whether to use the technology or not. In addition, beliefs about teaching and learning held by instructors are also among the important challenges that influence e-learning implementation in their courses (Phillips, 2005).

Access to the ICT infrastructure is another serious challenge. Only 4% of the African population have access to and use computer and internet (Resta & Laferriere, 2008). Despite the fact that availability of mobile phones for educational uses has enjoyed phenomenal growth across Africa (Pena-Bandalaria, 2007), the effective use of this gadget is also to some extent limited by challenges such as cost (Nnafie, 2002), limited screen size, battery life, memory and design of content for m-learning delivery (McGreal, 2009). In sub-Saharan Africa's universities, studies have shown that access to different e-learning technologies differs between instructors and students (Aguti & Fraser, 2006; Nnafie, 2002). For example, Aguti and Fraser (2006) reported that more than 60% of the students in their study lacked access to video, computer and internet.

Narrow bandwidth that affects internet speed is another big challenge in most sub-Saharan African countries. According to Gakio (2006), the state of internet connectivity in tertiary institutions in Africa is characterized as: "*too little, too expensive and poorly managed; as a result internet technology becomes even less useful for research and education purposes*" (p. 41).

Limited competence and skills on the part of both instructors and students is also a challenge for implementation of e-learning technologies (Hoven, 2000). A large proportion of instructors and most students have limited competence and skills in using new technologies (Hoven, 2000). Instructors and students with poor computer competences and skills perceive e-learning technologies use as difficult, compared to those with good competence and skills for computer use (Siritongthaworn et al., 2006).

Instructor-Student Interaction Through E–Learning Technologies

Among other uses, e-learning technologies are used in most developed countries to enhance interactions among instructors and students (Dabbagh & Kitsantas, 2005) and for providing feedback to students (Dunn & Lingerfelt, 2004; Malikowski & Theis, 2006). Increased interactions as a result of application of e-learning technologies lead to increased student satisfaction, retention and graduation rates in distance education (Malikowski & Theis, 2006). E-learning technologies such as e-mail are also useful for providing feedback to students in the form of instructors' comments (Malikowski & Theis, 2006). Moreover, students find interactions through e-mail communication interesting and useful for exchanging information among themselves and between themselves and instructors (Dabbagh & Kitsantas, 2005).

Course Delivery, Access and Academic Outcomes

E-learning technologies such as learning management systems are commonly used to deliver courses and learning resources to students (Dunn, 2004). According to Malikowski and Theis (2006), course delivery by a learning management system provides convenient, individualized and high-quality instruction. E-learning technologies enhance students' access to learning resources as well (Dunn, 2004; Papastergious, 2006).

In terms of improving students' academic outcomes through e-learning implementation, the existing studies provide mixed evidence. Although Bates (2000) reported significant improvements in students' academic outcomes as a result of the application of e-learning in teaching and learning, a study by Summers, Waigandt, and Whittaker (2005) reported no significant difference in outcomes between e-learners and traditional instruction groups. Summers et al. (2005) found that in order for students to benefit from e-learning technologies, instructors need to organise courses such that they adequately take the following into account: (i) course task characteristics, (ii) student characteristics, (iii) student motivation, and (iv) instructor characteristics. Summers et al. (2005) further argued that when those attributes are not taken into consideration, students are likely to experience fewer benefits from e-learning.

Purpose of the Study

The purpose of the study reported in this chapter was to investigate the impact of *collaborative course design* on instructors' practices and students' academic outcomes at the Open University of Tanzania (OUT). The main question was formulated as: *What is the impact of collaborative course design on instructors' instructional practices and students' academic outcomes?* The following sub-questions guided the study:

1. In what ways did collaborative course design contribute to instructors' preparedness for e-learning implementation?
2. How did the instructional practices of instructors change during e-learning implementation?
3. How did students experience e-learning implementation?
4. What was the impact of e-learning implementation on students' academic outcomes?

Intervention

The professional development intervention involved collaborative course design and delivery. Collaborative course design consisted of workshops, the redesign of courses in design teams, and general meetings of the design teams. The redesigned courses were then delivered. During course delivery the general meetings continued. Instructors from the Faculty of Science, Technology and Environmental Studies (FSTES) and from the Institute of Continuing Education (ICE) were invited to participate in two workshops (one prior to course design and one at the end of course design).

The first workshop, which lasted for 3 h, aimed to prepare instructors for how to redesign their print-based courses into e-learning courses. It also oriented instructors regarding e-learning course design, particularly how to plan and write different materials for e-learning courses (e.g., preparing PowerPoint slides, searching for resources, lesson notes, and study materials, etc.). The workshop used presentations and demonstrations of exemplary e-learning courses that had been developed during a pilot study to stimulate discussions on course redesign. Two instructors acted as facilitators during the workshop.

After the first workshop, instructors worked in design teams to redesign their courses. The emphasis was on redesigning existing courses rather than developing new ones. Instructors spent 2.5 months on redesigning their courses. Five general meetings were convened for the teams where questions were answered, topics discussed and choices made. The general meetings provided the design teams with opportunities to discuss different challenges, issues and problems related to the course redesign process. Pedagogical support was provided to the design teams in the general meetings.

A final workshop lasting 2 h was convened after all e-learning courses had been developed to orient instructors regarding e-learning course delivery and how to use e-mail and mobile phones to interact with students during the course. The redesigned courses were then delivered to students at the regional centres through Moodle LMS. Twelve courses were installed in Moodle LMS in a computer laboratory at the Dar es Salaam, Singida and Manyara regional centres. During implementation of the redesigned courses, four general meetings were convened for instructors to reflect about the on-going course delivery. The courses were delivered over 12 weeks.

Methods

Design of the Study

To answer research questions 1 and 2, a *multiple case* research design (Yin, 2003) was employed. Two cases, that is, the Faculty of Science, Technology & Environmental Studies (FSTES) and the Institute of Continuing Education (ICE), were explored during the study. Instructors involved in the study were considered as the units of analysis and OUT as the context of the study. The same design was used to collect data from students to answer research question 3. In this respect, three cases (i.e., the Dar es Salaam, Singida and Manyara regional centers) were considered and students involved in the study were regarded as the units of analysis. To answer research question 4, a quasi-experimental research design was employed. Students at the Dar es Salaam, Singida and Manyara regional centers were assigned to experimental and control groups. Students were purposefully assigned to the experimental and control groups. The criteria of geographical location, knowledge about and access to computers and internet were mainly considered. The experimental group was comprised of students who were located in the township and had knowledge about and access to computers and internet, either at the OUT headquarters or at their respective centers. The control group, on the other hand, was mostly comprised of students from both the township and remote areas who lacked knowledge about and/or access to computers and internet. Students in the experimental group were oriented regarding how to use Moodle LMS during the course, after which they accessed courses for a period of 12 weeks through computers at the computer laboratory in their respective regional centers.

Participants

Instructors

Twelve instructors, eight from the FSTES and four from the ICE, participated in the study and delivered their courses to students at the regional centers through Moodle. The instructors from FSTES were selected because they were involved in teaching courses that were identified by the faculty to be converted into e-learning courses. The four instructors from ICE were selected based on their interest in participating in the study. All instructors were based in Dar es Salaam; their average age was 37 and 41, in FSTES and ICE respectively. Instructors had different teaching experience and all had excellent computer and internet skills.

Students

A total of 553 students drawn from the Dar es Salaam, Singida and Manyara regional centres participated in the study. Table 14.1 provides the background characteristics of students collected via the students' questionnaire. There were 337 students in the experimental group and 216 students in the control group.

Table 14.1 Student background characteristics

	Regional Centres		
Characteristics	Dar es Salaam	Singida	Manyara
Students with e-learning delivery (experimental group)	210	76	51
Faculty/institute			
FSTES	63	38	35
ICE	275	90	52
Gender			
Male	102	31	24
Female	107	45	28
Computer experience	1.5–2 years	4 months–1 year	4 months–1 year
Computer skills	Good	Good	Good
Frequency of computer use	At least 4–5 times per week	At least 2–3 times per week	At least 2–3 times per week
Access to computer and internet	At OUT library and internet cafe	At workplace, regional centre and internet cafe	At regional centre and internet cafe
Students with print-based delivery (control group)[a]	128	53	35

[a]Students in the control group did not complete the student questionnaire, and therefore did not provide information about background characteristics

Instruments and Data Analysis

The following instruments were used: *interview guide for instructors*, *course analysis guide, questionnaire for students,* and *university examination for students.* The interview guide for instructors was used to collect data on the impact of collaborative course design on instructors' instructional practices. Each instructor was interviewed at the end of course delivery. A total of 12 interviews were conducted, transcribed and transported into *Atlas.Ti*. Deductive and inductive coding was used to analyze the data. Clusters and sub-clusters were identified (Miles & Huberman, 1994). Samples of the interview responses of four instructors were re-coded by a colleague in the department using a provided list of codes. Inter-rater reliability was .84 (Cohen's κ) indicating good reliability.

Courses that were redesigned by instructors in the design teams were analyzed using a *course analysis guide* which was developed for the study. The guide sought to explore the kind of learning resources that each course contained. *Questionnaires* were administered to students in the experimental group at each regional centre at the end of the 12 weeks. The questionnaire explored students' experiences with the e-learning courses and delivery. Around the same time, University Examinations (UE) were administered to students (from both the experimental and the control groups) to determine the impact of the e-learning courses and delivery on their academic outcomes. Data from questionnaires and UE were analysed and descriptive statistics (means, standard deviations and frequencies) were computed. In addition, *t*-tests and an ANOVA post-hoc test were used to calculate differences between regional centres and instructional approaches.

Results

Instructors' Preparedness for E-Learning Implementation

Results in Table 14.2 show that collaborative course design contributed to instructors' preparedness for e-learning implementation in four ways. Collaborative course design (i) promoted knowledge of *challenges* of print-based delivery for distance learning implementation; (ii) ensured *support;* (iii) allowed *collaboration;* and (iv) facilitated *encouragement* from colleagues.

All instructors (except T6 and T7 from FSTES and T11 from ICE) indicated that working in design teams made them discuss the challenges they encounter in print-based delivery. According to the instructors, such an opportunity contributed to their preparedness for using e-leaning technologies, as indicated by T12:

> I knew the challenges of delivering courses by study materials, but I never took time to think about them nor thought of using technologies. The professional development was so specific in stimulating discussions in the general meetings on the challenges that are caused by dependence on print-based teaching. It provided an opportunity to discuss the best way to address the challenges by technologies. This contributed to using Moodle in my teaching. (T12)

According to the instructors, despite few demonstrations, dialogues in the design teams helped them understand why they should consider using Moodle, e-mail and mobile phones in their teaching. The following statement by T4 is an example:

> The workshops were useful despite few demonstrations on how to use Moodle. They (the workshops) opened up discussions about why e-learning technologies should complement

Table 14.2 Contribution of collaborative course design to instructors' preparedness

	Faculty of Science, Technology and Environmental Studies *(n = 8)*								Institute of Continuing Education *(n = 4)*			
	DT 1		DT 2		DT 3		DT 4		DT 5		DT 6	
Ways	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Challenges/ reasons	x	x	x	x	x	o	o	x	x	x	o	x
Support	x	x	o	o	x	x	o	o	x	x	x	x
Collaboration	x	x	o	x	x	x	x	o	o	x	x	x
Encouragement	x	x	x	x	x	x	x	x	x	o	x	o

x = Did contribute in this way, o = Did not contribute in this way
DT design team, *T* Teacher/Instructor

> print delivery of course. The professional development made me aware of the reasons for using e-learning technologies in the teaching process, which contributed to my using of Moodle and e-mail to deliver courses. (T4)

It is evident from Table 14.2 that the support offered to the instructors also helped instructors feel prepared to implement e-learning. There were two perspectives expressed about support. In the first perspective, instructors (particularly those in FSTES) indicated *"support by the faculty and the university management contributed to the implementation of Moodle in course delivery"* (T7). In the second perspective, all instructors in ICE and half of the instructors in FSTES indicated that the pedagogical and technical support offered by the support staff and colleagues also promoted their confidence, which contributed to e-learning implementation in their teaching. A comment from T12 expressed the experiences of the majority of instructors:

> I found the supportive environment in the design team as a contributing factor to successful implementation of e-learning technologies in my teaching. The pedagogical and technical support offered during the professional development ensured sufficient experience in integrating technologies in the delivery of courses. I enjoyed working with colleagues and supporting each other; this made us competent in using Moodle, e-mail and mobile phones for course delivery. (T12)

Furthermore, the results in Table 14.2 show that three-quarters of the instructors (except for T3 and T8 from FSTES and T9 from ICE) indicated that *collaboration* in design teams contributed to their preparedness to use e-learning technologies in teaching. According to one of the instructors, *"collaboration allowed sharing and exchange of ideas and experiences about course delivery (by Moodle) and support of students (by e-mail and mobile phones), which promoted confidence and preparedness to use such technologies"* (T4).

The majority of the instructors (except for T10 and T12) also felt that e*ncouragement* contributed to e-learning implementation, and here again there were two perspectives. In the first perspective, instructors indicated that *"encouragement by colleagues in the design teams and general meetings motivated them to transform their courses for delivery using e-learning technologies"* (T9). In the second perspective, the majority of the instructors from FSTES (exemplified by T5) expressed that "*encouragement by colleagues in the faculty and the board members who were very supportive of the e-learning implementation idea, contributed to the use of Moodle in the faculty"* (T5).

Instructional Practice of Instructors

All instructors found using Moodle LMS to deliver courses and resources to students to be interesting. The following statement by one of the instructors expressed the experience of the majority of the instructors: *"Developing the courses was a bit challenging but I enjoyed using Moodle to deliver my course. I found using it*

Table 14.3 Learning resources offered by courses in Moodle LMS

Resources and materials	Faculty of Science & Environmental Studies *(n = 8)*								Institute of Continuing Education *(n = 4)*			
	DT 1		DT 2		DT 3		DT 4		DT 5		DT 6	
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
Course outline	o	x	x	x	x	x	x	x	x	x	x	x
Study material	o	o	x	x	x	o	x	x	o	x	x	x
Articles	x	x	x	x	o	x	o	o	x	x	x	o
Lesson notes	x	x	x	x	x	x	x	x	x	x	x	x
Lesson activity	o	o	o	o	o	x	o	x	x	o	o	o
PowerPoint slides	x	x	x	x	x	x	x	x	o	x	x	x

x = material/resource was offered, o = material/resource was not offered
DT design team, *T* Teacher/Instructor, *C* Course

[Moodle] interesting and useful particularly because it allowed delivery of learning materials and articles to students during the course" (T10).

Analysis of the redesigned courses in Moodle LMS revealed that there was diversity in terms of how many learning resources were contained in each course (Table 14.3). Note that most of the courses included course outlines (all but one), study materials, lesson notes, PowerPoint slides (all but one), and review questions (all but one).

Furthermore, results from the interviews indicated that instructors used e-mail and mobile phones (mostly text messages) to interact with students during the course more than before. None of the instructors reported having used postal services during the course. The statement by one of the instructors (T6) is an example:

> Unlike before, I communicate with students regularly through mails and sometimes text messages. I have to check my e-mails regularly than before to make sure that I don't miss replying student's e-mails on time. Previously I used e-mail only for communicating with friends and relatives but now I can use it to communicate with students.

The majority of the instructors expressed that they used e-mail mostly for providing (i) course outlines, (ii) learning resources such as study materials and articles, and (iii) feedback to students.

Students' Experience with E-Learning Courses

Table 14.4 shows that students at all three regional centres studied were positive about the courses because they found the *courses clear* and that e-learning made interaction and communication with instructors more *flexible*.

Table 14.4 Students' experience with courses and e-learning delivery

E-learning characteristics	Regional centres		
	Dar es Salaam (n = 210)	Singida (n = 76)	Manyara (n = 51)
	Mean (SD)	Mean (SD)	Mean (SD)
Course clarity	4.4 (.60)	4.3 (.60)	4.3 (.56)
Flexibility	4.4 (.58)	4.3 (.48)	4.3 (.51)

Scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree

Table 14.5 Ways that e-learning technology addressed challenges of print-based delivery

Ways	Regional centres		
	Dar es Salaam (n = 210)	Singida (n = 76)	Manyara (n = 51)
	Mean (SD)	Mean (SD)	Mean (SD)
Learning support	3.9 (.61)	3.8 (.58)	3.7 (.58)
Delivery	4.2 (.71)	4.0 (.79)	4.3 (.54)
Limitations	2.7 (1.1)	2.5 (1.0)	2.3 (.98)

Scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

Table 14.5 shows that students across regional centres reported that e-learning technologies improved *learning support.* E-learning technologies enhanced course *delivery*. In particular, with e-learning, students were able to get sufficient and up-to-date learning resources during the course and there was timely delivery of course outlines. The students' major concern was the fact that the offline Moodle system was *limited* in location and time. No significant difference in *learning support, delivery* and *limitations* were found between regional centres.

A large proportion of students at all three regional centres indicated that it was easier to access courses and resources with e-learning than with print-based delivery (Table 14.6).

Students' Academic Outcomes

The impact of e-learning implementation on students' academic outcomes is presented in Table 14.7.

The results show that e-learning implementation had a statistically significant positive impact on the academic outcomes of students in all courses but 3, as indicated by the respective p values for the t-tests conducted. The magnitude of the impact of e-learning implementation on academic outcomes was between medium and large (effect size values between .3 and .6).

Table 14.6 Comparing access to resources between e-learning and print-based delivery

Resources	Perceived ease of access to learning resources (in %)					
	Easier in e-learning delivery			Easier in print delivery		
	DSM (n = 210)	SGD (n = 76)	MNY (n = 51)	DSM (n = 210)	SGD (n = 76)	MNY (n = 51)
Course outlines	64.3	75.0	80.4	29.0	18.4	15.7
Articles	85.2	90.8	92.2	6.7	6.6	5.9
Lecture notes	86.2	89.5	92.2	4.8	3.9	3.9
Study materials (soft copies)	83.3	77.6	80.4	5.7	9.2	9.8

DSM Dar es Salaam, *SGD* Singida, *MNY* Manyara

Table 14.7 Students' academic outcomes in e-learning and traditional print-based delivery

Courses	E-learning (n = 337)	Print (n = 216)	Effect size
	Mean (SD)	Mean (SD)	(Cohen's d)
Introduction to probability and statistics	49 (23)	48 (11)	.06
Communication skills for IT*	54 (15)	48 (11)	.46
Computer ethics and cultural implications**	56 (13)	51 (9)	.45
Information systems planning and management**	56 (12)	49 (13)	.56
Introduction to computer security*	55 (14)	50 (9)	.42
Introduction to microcomputer applications I**	52 (13)	45 (11)	.58
Introduction to numerical methods	53(12)	54 (7)	−.10
Network design and administration**	55 (11)	50 (11)	.45
Physics**	55 (13)	50 (11)	.42
Development studies	54 (12)	53 (12)	.08
Communication skills**	52 (12)	49 (11)	.26
Geography**	55 (13)	51 (12)	.32

* $p < .05$; ** $p < .01$

Discussion and Conclusions

The study reported in this chapter investigated the impact of *Collaborative Course Design* on instructors' instructional practice and students' academic outcomes at the Open University of Tanzania. The results showed that *Collaborative Course Design* had a positive impact on instructors' instructional practice. Consistent with other studies (e.g., Voogt, 2010; Voogt, Almekinders, Van den Akker, & Moonen, 2005), *Collaborative Course Design* was effective in preparing instructors to use Moodle LMS (supported by e-mail and mobile phone) to deliver courses. As a result of

Collaborative Course Design, instructors developed positive perceptions regarding the use of both e-mail and mobile phones. According to the instructors, e-mail was useful for sending course outlines, additional learning resources (e.g., articles), and feedback to students (cf. Dabbagh & Kitsantas, 2005).

It was also established during the study that *Collaborative Course Design* provided an opportunity for instructors to discuss challenges of their traditional instructional practice, as well as the rationale for and the potential of e-learning technologies. This was possible because instructors acknowledged that expertise is shared and that good ideas about how to organize e-learning courses emerged through conversations and collaborations at both the design and implementation phases of course delivery (cf. Stewart, Cohn, & Whithaus, 2016). As found by Simmie (2007), the support offered to instructors during course design and delivery, as well as collaboration and encouragement by colleagues, were critical and contributed to the effectiveness of *Collaborative Course Design*.

After experiencing e-learning for the first time, the students had a positive experience with e-learning delivery. They found courses to be clear in terms of content, structural layout and organization. Interactions with instructors by e-mail and mobile phone communications were flexible, and none of students used postal services during the course. Unlike in traditional print-based delivery, students in e-learning delivery used communication technologies to interact with instructors during the course for different learning needs. Students typically used the technologies they found most convenient: Whereas e-mail seemed convenient for students in Dar es Salaam, those in Singida and Manyara preferred mobile phones (usually short text messages). Access to communication technologies may have influenced students' decision on what technology to use. According to Malikowski and Theis (2006), increased interactions lead to increased satisfaction and retention of students in distance education.

Regarding student learning, the results revealed that, consistent with other studies (Bates, 2000), e-learning delivery had a positive impact on students' academic outcomes in all (but three) courses, with a medium effect size, in general. According to Cohen (1988), it is worthwhile investing resources in educational innovations with a medium effect size. The success in student learning is associated with the fact that the e-learning technologies addressed the challenges of print-based delivery, in particular by improving the delivery of courses and access to course outlines, soft copies of study materials and articles. E-learning also enhanced the provision of learning support to students through e-mails and mobile phone. Similar results have been reported in other studies (Bates, 2000; Dunn, 2004; Papastergious, 2006). According to Summers et al. (2005), reasons such as the motivation of students, the nature of lesson activities, student characteristics and instructor characteristics also made students benefit more from an e-learning environment. The major concern of students pertained to the location and time limitations of offline Moodle, since it required them to visit the centre to access courses and resources.

It is recommended that the university should consider investing resources towards up-scaling of e-learning implementation for course delivery across faculties and institutes. In this case, *Collaborative Course Design* can be used to prepare instructors for e-learning course design, delivery and implementation. Together with this, efforts should be made to understand the available opportunities and challenges that can support or hinder large-scale e-learning implementation at the Open University of Tanzania.

The promising results related to *Collaborative Course Design* as a strategy for e-learning implementation offer possibilities for other academic institutions to systematically implement e-learning to enhance programme delivery through distance education in sub-Saharan Africa. Numerous studies have already been reported that can be considered as offering exemplary practices on how to organize *Collaborative Course Design* as a strategy for instructors' preparation in the context of sub-Saharan Africa (Kafyulilo, Fisser, & Voogt, 2016; Stewart et al., 2016).

References

Aguti, J. N., & Fraser, W. J. (2006). Integration of information communication technologies (ICTs) in the distance education bachelor of education programme, Makerere University, Uganda. *Turkish Online Journal of Distance Education, 7*(3), 89–104.

Bakari, J. K. (2009). *ICT at the Open University of Tanzania: Achievements, challenges and future prospects*. Report presented during Rolling Strategic Plan review at Golden Tulip Hotel, April, 2009, Dar es Salaam, Tanzania.

Bates, A. W. (2000). *Managing technological change: Strategies for college and university leaders*. San Francisco: Jossey-Bass.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Dabbagh, N., & Kitsantas, A. (2005). Using web-based pedagogical tools as scaffolds for self-regulated learning. *Instructional Science, 33*, 513–540.

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy, 24*(2), 81–112.

Dunn, T. K. (2004). The interplay between a course management system and pre-service teachers' knowledge, beliefs and instructional practices. *The Journal of Interactive Online Learning, 2*(3), 1–7.

Dunn, D. L., & Lingerfelt, D. (2004). Integrating WebCT into the computer science curriculum. *Journal of Computing Sciences in Colleges, 19*(4), 335–341.

Dzakiria, H. (2004). Technology does not always teach distance learners, but effective distance teachers do. *Malaysian Online Journal of Instructional Technology, 1*(1), 60–81.

Fozdar, B. I., & Kumar, L. S. (2007). Mobile learning and student retention. *International Review of Research in Open and Distance Learning, 8*(2), 1–18.

Gakio, K. (2006). *African tertiary institutions connectivity survey*. Report commissioned by the International Development Research Centre of Canada. Retrieved from http://www/aau.org/renu/docs/ATICS2006.pdf on 20th Sept, 2009.

Hoven, K. (2000). *A study on the potentials of information and communication technologies in university education in Tanzania. A case study of the University of Dar es Salaam* (Master's thesis). Nijmegen, The Netherlands: Radboud University.

Kafyulilo, A., Fisser, P., & Voogt, J. (2016). Teacher design teams as a professional development arrangement for developing technology integration knowledge and skills of science teachers in Tanzania. *Education and Information Technologies, 21*(2), 301–318.

Kirkwood, A., & Price, L. (2005). Learners and learning in the twenty-first century: What do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? *Studies in Higher Education, 30*(3), 257–274.

Ludwig-Hardman, S., & Dunlap, J. C. (2003). Learner support services for online students: Scaffolding for success. *International Review of Research in Open and Distance Learning, 4*(1), 1–15.

Malikowski, S. R., & Theis, J. G. (2006). *Distance education courses: How course management systems are used and factors affecting use*. Paper presented during the 22nd annual conference on Distance Teaching and Learning.

McGreal, R. (2009). *Mobile devices and the future of free education*. Paper presented at Maastricht's 23rd International Conference on Distance Education. Retrieved from: http://www.ou.nl/Docs/Campagnes/ICDE2009/Papers/Final_paper_296Cosmas.pdf on 25 June 2009.

Mcharazo, A., & Olden, A. (2002). Fulfilling the learning resource requirements of students at the Open University of Tanzania. *Journal of Librarianship and Information Science, 32*(4), 204–214.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). London: Sage.

Mishra, P., Koehler, M. J., & Zhao, Y. (2007). *Faculty development by design: Integrating technology in higher education*. Charlotte, NC: Information Age Publishing.

Nihuka, K. A., & Voogt, J. (2011). Instructors' and students' competences, perception and access to e-learning technologies: Implications for e-learning technologies at the Open University of Tanzania. *International Journal on E-Learning, 10*(1), 63–85.

Nnafie, I. (2002). *Internet cafes in Dar es Salaam: Problems and opportunities* (Master's thesis). Eindhoven University of Technology, The Netherlands.

Papastergious, M. (2006). Course management systems as tools for the creation of online learning environments: Evaluation from a social constructivist perspective and implications for their design. *International Journal of Technology and Teacher Education, 10*(3), 383–405.

Pena-Bandalaria, M. D. (2007). Impact of ICTs on open and distance learning in a developing country setting: The Philippine experience. *International Review of Research in Open and Distance Learning, 8*(1), 1–15.

Penuel, E. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Phillips, R. A. (2005). Challenging the primacy of lectures: The dissonance between theory and practice in university teaching. *Journal of University Teaching and Learning Practice, 2*(1), 1–17.

Resta, P., & Laferriere, T. (2008). Issues and challenges related to digital equity. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 765–778). New York: Springer.

Sife, A. S., Lwoga, E. T., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *International Journal of Education and Development Using Information and Communication Technology, I*(20), 57–67.

Simmie, G. M. (2007). Teacher design teams (TDTs) – building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies, 26*(2), 163–176.

Siritongthaworn, S., Krairit, D., Dimmitt, N. J., & Paul, H. (2006). The study of e-learning technology implementation: A preliminary investigation of universities in Thailand. *Educational Information Technology, 11*, 137–160.

Stewart, M. K., Cohn, J., & Whithaus, C. (2016). Collaborative course design and communities of practice: Strategies for adaptable course shells in hybrid and online writing. *Transformative Dialogue: Teaching & Learning Journal, 9*(1), 1–20.

Summers, J. J., Waigandt, A., & Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education, 29*(3), 233–250.

Thomas, P., & Carswell, L. (2002). Learning through collaboration in a distance education environment. *Educational Technology and Society, 3*(3), 373–383.

Voogt, J. (2010). A blended in-service arrangement for supporting science teachers in technology integration. *Journal of Technology and Teacher Education, 18*(1), 83–109.

Voogt, J., Almekinders, M., Van den Akker, J., & Moonen, B. (2005). A 'blended' in-service arrangement for classroom technology integration: Impacts on teachers and students. *Computers in Human Behaviour, 21*, 523–539.

Yin, R. K. (2003). *Case study research design and methods* (3rd ed.). London: Sage.

Chapter 15
Improved Internship Practices as a Result of Collaborative Curriculum Design

Edward Akomaning

Introduction

The role of teachers in curriculum development, particularly in tertiary education, cannot be underestimated. Promising educational projects have failed because teachers were alienated from the educational reform at its commencement (Doyle & Ponder, 1975). It is therefore imperative to involve teachers in the various phases of educational reforms. Because of their training, role and position in the educational system, they are in a better position to understand when and how subject matter should be taught (Fullan, 2007). However, in this day and age when the quality of tertiary graduates has become a subject of public discussion, it is equally important also to involve other stakeholders in curriculum development, so that the products that are designed are not perceived by other stakeholders as an imposition (Van den Akker, 2003) and therefore lack credibility during implementation. The shared responsibility becomes even more crucial when the development of the curriculum pertains to an internship programme, where educational institutions and industry need to cooperate closely to make it a successful learning experience for students. Thus, stakeholders' collaborative planning, in which the needs and interests of stakeholders are elicited, becomes paramount (Center for Careers, Life, and Service, 2014; Lewis, 2004).

Internship has become an important part of the curriculum of higher education (Beggs, Ross, & Goodwin, 2008; Domask, 2007; Lam & Ching, 2006; Walo, 2001), serving as an avenue through which the industry complements what is taught in the

E. Akomaning (✉)
Institute for Educational Planning and Administration, University of Cape Coast, Cape Coast, Ghana
e-mail: eakomaning@ucc.edu.gh

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_15

classroom (Rothman, 2007). Internship as part of a formal education programme is an educational activity intended for students' acquisition of such competencies as are needed to obtain the required qualification at the end of their programme. In order to better provide high quality internship experiences, it is vital that internship stakeholders, particularly industry personnel and students, have comparable perceptions and expectations of the internship experience.

A previous study of the current situation of internship in the hospitality management sector in Ghana's polytechnics revealed that polytechnic-industry collaboration needs to be strengthened, interns need to have experience in all sectors of the industry, and curriculum materials need to be designed to guide student internships (Akomaning, Voogt, & Pieters, 2011). This previous study further disclosed an episodic relationship between polytechnics and industries, lack of job rotation, lack of supervision of interns by teachers and industry-based supervisors, and the need for improvement in assigned work and student competencies. Other findings hint at the need for industry workers to cooperate with interns and the need for curriculum materials to be designed to streamline student internships. Therefore, the improvement in student internship programmes is an important aspect of the preparation of qualified staff for the sector and is a major concern in the curriculum reform in Ghana's polytechnics (Gervedink Nijhuis, Bakah, & Akomaning, 2009). In order to address this need, the studies reported in this chapter adopted collaborative curriculum design (CCD) in teacher design teams as a strategy for collaboratively designing curriculum materials to improve student internships.

CCD is a bottom-up approach to curriculum improvement in which a group of teachers, teaching the same subjects or related subjects, work together on a regular basis with the ultimate goal of (re)designing and implementing (a part of) their common curriculum (Handelzalts, 2009). The underlying assumption for adopting the concept of CCD for our studies is that when teachers, who play very crucial roles when it comes to curriculum interpretation and implementation, are involved in curriculum design, they could be in a better position to incorporate materials that are relevant and practical for all stakeholders involved (i.e., students, teachers and industry personnel).

This chapter addresses two studies that aimed to contribute to an improved student internship curriculum for the hospitality management sector in Ghana's polytechnics by involvement of and collaboration among relevant stakeholders in the design of curriculum materials for internship. In the studies reported in this chapter, polytechnic teachers collaboratively designed curriculum materials to improve student internship in the hospitality industry, with input from students and industry personnel. The curriculum materials were implemented and the outcomes of the implementation examined. The underlying hypothesis was that CCD would lead to high quality curriculum products, culminating in smooth implementation and effective organisation of student internships.

Theoretical Underpinnings

Prerequisites for Implementation of a Renewed Internship Curriculum

Internships have a long and noteworthy history in higher education (Beggs et al., 2008). Internship provides an opportunity and a learning scenario for students to experience, first-hand, professional practice activities that directly relate to the application of knowledge. Bakar, Harun, Yusof, and Tahir (2011) considered internship as an opportunity to integrate career-related experience into an education programme by participating in planned and supervised work. According to Clark and Whitelegg (1998), internship fosters "learning by doing", which in its turn reinforces the understanding of complex concepts and the development of complex skills. A successful internship requires conceptualising the internship situation more clearly as an authentic workplace learning environment (Blokhuis & Nijhof, 2008) in which industry's contributions can be best organised to assist the learning required of the intern. Hasbullah and Sulaiman (2002) asserted that students' competencies improved remarkably after their experience in industry through the use of curriculum materials for student internship. The use of curriculum materials specifying what is to be learnt and who is responsible for what could create a better platform for internships to be better organised (Ko, 2008).

Internships also afford student training under both academic and practitioner supervision (Barber & Bailey, 2015; Beggs et al., 2008). This supervision allows students to gain interpersonal skills with industry workers (Thiel & Hartley, 1997). However, in order to ensure that the internship experience meets the needs of the industry, teacher and student, it is important to ensure that there are curriculum materials specifying their roles in the internship. In addition, articulating the responsibilities of interns and internship supervisors (educators and industry-based) prior to the internship is a key element in a successful internship (Beggs, Ross, & Knapp, 2006; Rothman, 2007).

Design Teams and Collaborative Curriculum Design

A design team is described as a collaborative group working together to produce a unit of instruction or to create a product (Waddoups, Wentworth, & Earle, 2004) that is implemented and evaluated (Handelzalts, 2009) in an educational institution's programme. It implies that in the design process teachers investigate challenges in their current instructional practice, (re-)design product(s), implement the product(s) and evaluate it. Collaboration in design teams contributes to enhancing teacher knowledge, skills and practices (Handelzalts, 2009; Simmie, 2007). The sense of security that comes from the support of colleagues in design teams results in greater willingness to experiment, try new things, and be more apt to consider continual development in curriculum reform (Hargreaves, 2003).

Participation in self-managed design teams, where members have the authority to make decisions and take actions to advance goals determined by the team, may intensify members' commitment to the team and foster collaboration among team members (Dee, Henkin, & Singleton, 2006; Waddoups et al., 2004). Teacher collaboration in design teams, according to Little (1990) and Riordan (2001), denotes joint work, shared responsibility and the existence of high levels of trust, respect and mutuality. Design teams' activities are most often guided by a common goal. Attributes such as cooperation, collaboration, consensus and teamwork are crucial to the success of design teams, which not only result in a concrete product, but also culminate in professional learning (Deketelaere & Kelchtermans, 1996; Fullan, 2007).

CCD in design teams is one such initiative, in which teachers get into teams to carry out activities that lead to both improvement in student learning (Havnes, 2009) and teacher professional development. Increasing levels of participation within a team are the key to how learning occurs (Blackwell, 2003). In fact, research has suggested that collaboration in curriculum design can potentially lead to several possible learning gains for teachers, such as increased content knowledge in a target domain (Kolodner et al., 2003; Rock & Wilson, 2005; Voogt et al., 2011) and improvements in general process and collaboration skills (Guskey, 2000; Kolodner et al., 2003). CCD in design teams was used in the present studies to prepare curriculum materials for the student internship programme for hospitality management students. This approach promotes collaborative planning incorporating the interests of students, teachers and industry personnel (Lewis, 2004).

Ensuring High Quality Curriculum Materials as a Result of Collaborative Design

According to Kessels and Plomp (1999), the quality of educational programmes in terms of their influence is determined to a large extent by the "consistency" of the curriculum. Internal consistency refers to the logical sequencing of the various components of the curriculum. Internal consistency is reached through a "systematic approach" (Kessels & Plomp, 1999), which implies the systematic design sequence of orientation, design, development, and evaluation. Denton, Kleist, and Surendra (2005) further asserted that the internal consistency of a curriculum could be improved by eliminating duplication or overlap of topics. External consistency, on the other hand, refers to the coherence of the perceptions of stakeholders (i.e., students, teachers and industry personnel) regarding the problem for which an intervention (e.g., collaborative design of curriculum materials) is needed and how it should be solved. External consistency is reached through a "relational approach", corresponding to the communicative paradigm (Kessels & Plomp, 1999). It implies the involvement of stakeholders in the design and development process, thereby revealing their perceptions of the main goals of the process and of how they should be achieved.

Our studies, therefore, use CCD in design teams as a means to realise both the internal and external consistency of the curriculum materials, because teachers play a significant role in facilitating teaching and learning (Hattie, 2003) as well as being conversant with what goes on in industry through their training and experience (Heath, 2010). The composition of design teams and their ability to elicit suggestions from other stakeholders in the design of curriculum materials for student internship cannot be overemphasized if high quality work is to be ensured (cf. Kessels & Plomp, 1999).

Practicality of the Curriculum Materials in Renewed Internship

Stakeholders' perceived attitude accounts for the successful use of a curriculum (Doyle & Ponder, 1975), which is prompted by how its contents and components are systematically aligned (relevance and consistence) with the requirements of end users. According to Nieveen (2009), a key characteristic of high quality curriculum materials is that end users (stakeholders) consider them to be usable and largely well-suited to the developers' intentions. In this vein, practical use of the materials by stakeholders during internship would be guaranteed, and ultimately implementation would be facilitated and the intended objectives of the renewed internship would be achieved, with expected outcomes (Sackney, Mitchell, & Walker, 2005).

Effects on Students' Competencies and Assessment of Curriculum Materials

The quality of curriculum materials should not rest simply on the relevance and consistency phase, but on its effects as a result of implementation. The main objective of training is to help interns gain knowledge, develop positive attitudes, and apply what they have learned to real-life practices (Wilson, Strutton, & Farris, 2002). Internship can therefore nurture the student's correct work attitude and cooperation with others (Heppell, 2004). The curriculum materials would hence be considered effective if the intended objective is realised in interns' competencies and attitudes.

Institutional Support for Renewed Internship

Formalisation of the relationship between school and industry by a written contract specifying the tasks of the internship that correspond to the learning objectives as well as the provision of appropriate insurance are characteristics that foster successful internship (Youth Forum Jeunesse, 2009). An internship coordinator should be designated to provide both the intern and the business with information and also to intercede when problems arise (Cook, Parker, & Pettijohn, 2004). Additionally, internship, as a form of career-related experience that complements what is learned in the classroom, builds upon the relationship that the educational institution has with employers and is most successful when the student, the department/polytechnic, and the employer all share responsibility for making it a valuable experience (Center for Careers, Life, and Service, 2014; Rothman, 2007).

Resolution of Implementation Challenges

A key component to making an internship programme stand out is job rotation. This allows interns to rotate among department functions to gain experience with a range of activities (Gillim, 2006). It is important for an intern to be continually and consistently evaluated from various points of view through periodical evaluations conducted each time the intern rotates into a different section.

Workplaces that make efforts to create positive working environments for interns could serve to increase not only the interns' effective commitment to the organisations, but also their long-term commitment to the occupation (Dixon, Cunningham, Sagas, Turner, & Kent, 2005). These authors contended that interns should be treated with the same respect as any employee, as friendliness and helpfulness go a long way in affecting an intern's opinion of an organisation.

The assumption underlying our studies is that with the support of management, CCD contributes to curriculum improvement, and hence to the improvement of student internships and student learning. In order to ensure successful improvement of the curriculum, all key stakeholders must be involved (Van den Akker, 2003). Research on teacher teams indicates that change is more likely to be effective and enduring when those responsible for its implementation are included in a shared decision-making process (Scribner, Sawyer, Watson, & Myers, 2007). The quality of working relationships among teachers is strongly related to the implementation of an educational innovation (Fullan, 2007). The crux of successful implementation of an educational programme is not losing sight of the context of the school.

The studies reported in this chapter were aimed at designing an improved student internship programme. The first study answered the question whether collaborative design teams contribute to an improved curriculum for student internship. The second study focused on the design of curriculum materials produced by the design teams and answered the question whether these materials contributed to a renewed student internship programme, according to the stakeholders involved.

Context of the Studies

Polytechnics in Ghana are part of the tertiary education system. Unlike the university, polytechnic education is practically-oriented and career-focused, preparing its students to provide middle-level manpower as supervisors and managers equipped with competencies that make them readily employable (or able to set up their own businesses) in the various sectors of the Ghanaian economy. However, the link between polytechnics and industry is episodic (Effah, 2005). In Ghana, industries are under no obligation to draw up a training programme for potential interns. Moreover, there is no policy on industries being compelled to give feedback on interns to polytechnics, which runs counter to the dictates of structured internships (McManus & Feinstein, 2008). Internship activities in the polytechnics are under the auspices of the Industrial Liaison Unit (ILU) in each polytechnic.

The department of Hotel Catering and Institutional Management (HCIM) has the responsibility is to train students to assume managerial or supervisory roles in the hospitality industry. The HCIM programme is a 3-year tertiary programme. Entrants into the programme are predominantly those who have successfully completed the Home Economics programme at their senior secondary school. Successful students graduate with a Higher National Diploma (HND) certificate in hospitality management. In order to adequately prepare students for the industry, internship is an integral component of the HCIM programme. Internships are carried out in two sessions throughout the 3-year programme. Each session spans a period of 3 months at the end of the academic year. In all, students are supposed to participate in at least 6 months of internship throughout the entire study period of 3 years. These internship periods are supposed to be supervised by both polytechnic educators and industry representatives.

First Study

This study sought to determine the effect of CCD in design teams on improved curriculum materials for the renewed student internship programme. The key research question framing this study was *Does collaborative curriculum design in design teams contribute to an improved curriculum for student internship?*

Designing Curriculum

Workshops were organised for stakeholders on the challenges identified in the context and needs study (Akomaning et al., 2011) and possible solutions to the challenges from stakeholders with the view of improving student internships. After that, two teams of teachers were formed to collaboratively design curriculum materials for student internships. Each team consisted of four teachers. One team developed materials for food production and food and beverage, and the other developed materials for accommodations and front office operation. The design of the curriculum materials took about 8 weeks.

The curriculum materials had the following components: objectives of student internship, content descriptions of the four core areas of the hospitality industry, practical activities the students had to carry out during student internship, job rotation during internship, assessment and student supervision from teachers and industry personnel. The main guidelines for designing a student internship curriculum, discussed in the introduction were applied in the design of the curriculum materials: the length of time of the internship, need for job rotation, support in achieving the expected objectives set for interns, installing industry supervision, and effective cooperation of supervisors with interns.

Method

Design of the Study

The study is a single-case design (Yin, 2003) in the context of the polytechnic and the case is the Department of HCIM at Tamale Polytechnic, with teachers, students and industry as units of analysis.

Participants

Eight teachers participated in two design teams. Three of them had previous experience in curriculum development. The Industrial Liaison Officer (ILO) participated because he is the kingpin regarding the organisation of internships and is the link between the polytechnic and industry. Fifteen industry representatives comprising 11 hotels and 4 hospitals were involved. A total of 66 1st-year ($n = 41$) and 2nd-year ($n = 25$) students took part in the workshops at the start of the curriculum design process. Fifty-three out of the 66 participated in the data collection after the new curriculum had been developed and implemented (number of students available at the time of administering the questionnaire). Of those 53, 23 students participated in the new internship programme implemented in 2009 (referred to as trained) and 30 students did not participate in the internship (referred to as untrained).

Instruments

Student Questionnaires

Two questionnaires were administered to students immediately after the meetings. The second questionnaire, similar to the first, was administered 5 months later, immediately after the internship. The questionnaires consisted predominantly of closed-ended statements, with responses on a five-point Likert scale and few open-ended questions on year group, gender, place of first and second internships and duration of the internships.

Teacher Questionnaires

Two questionnaires were administered to teachers. The first was administered immediately after the workshops. The rationale was to elicit background information on teacher experience with curriculum activities and their competencies in this regard, which were addressed by open-ended questions. The closed-ended items were responded to using a five-point Likert scale. The second questionnaire was administered to teachers after students had returned from their internships and was similar to the first one with some additions about support for design teams, and about satisfaction with involvement of stakeholders. Open-ended questions included: institutional support for design teams, the role played by teachers during the internship, problems encountered, assessment criteria, type of training students experienced, competencies acquired during design team sessions, and change in teacher perceptions about design teams.

Recorded Sessions

Design team sessions were recorded and analysed to support data about teacher perceptions of CCD.

ILO Interview

The ILO was interviewed after the internship concerning his role and contribution to the internship. He also answered questions on role expectations in other polytechnic groupings regarding the organisation of the internship, on challenges facing the unit and suggestions for improvement.

Industry Personnel Questionnaire

The questionnaire administered to hotel industry and hospital personnel was mainly closed-ended items using a five-point Likert scale for responses, with a five open-ended questions. The close-ended items focused on formalisation of links between polytechnic and industry, active involvement of teachers in student internships, teacher and industry supervision, making students write reports that form part of their assessment and industry personnel's reports on students' performance to the polytechnic. The open-ended questions centred on name and type of organisation, position of respondent, description of training given to students, departments served by student(s) and the impact of curriculum materials on student internship.

Checklist and Researcher Logbook

The checklist was used to collect data during visits to students in organisations by the researcher. The purpose was to know first-hand the interns' situation and to interact with personnel at the organisations concerning the interns' general behaviour.

Main Findings

Some considerable improvements in internship practices could be observed. The internship was perceived by the interns to be beneficial and interns' acquisition of competencies in the four main domains of the hospitality industry was significant. The first-year students improved remarkably in their competencies in food and beverage and accommodations operations whereas the second-year students improved in front office operation. In comparison with other departments in the hospitality industry, the most restrictive department for interns, particularly the first-year students, is the front office, because industry personnel are selective when it comes to assigning interns to this department. This might have accounted for the marked improvement in the competencies of second-year students.

This study examined how design teams that received input from students and industry representatives collaboratively designed curriculum materials to improve student internships in the Department of HCIM at Tamale Polytechnic. The teachers, having collaborated over a period of 8 weeks, were positive about the CCD in design teams, which resulted in marginal improvement in their collaborative skills as expressed in professional commitment, interdependence, mutual respect, healthy interpersonal relationship and participatory decision making. The study also revealed that involvement of the polytechnic, teachers and industry regarding student internship needed to be strengthened.

The curriculum materials were a source of guidance for both students and industry personnel. Teachers' lack of active involvement in the internship was due to the polytechnic's inability to provide the required resources to complement the efforts of industry. Students and industry personnel were satisfied with the job performance of students, but not teachers.

With support from the polytechnic administration as well as the support from industry and students, the design teams' activities led to the design of the improved curriculum materials that were used in the 2009 student internship programme. Hitherto, there had been no such guide. Teachers were of the opinion that CCD in design team creates a platform for sharing experiences with colleagues in a collegial atmosphere, which confirms the suggestion from other studies (see other chapters in this volume) that CCD in design teams with support can promote teacher learning and the collaborative skills of teachers. The marginal change in teacher perceptions could be due in part to the short-term nature of their activities in design teams.

Teachers', students' and industry personnel's views on the polytechnic's support for student internship were that it was very minimal (provision of introductory letter and assessment form to students willing to enroll in internship), and that the polytechnic-industry relationship needed to be strengthened. Teacher supervision of students during internship was absent, but the industry contribution on the whole was commendable. Students and industry personnel were positive about industry supervision, which was partly attributable to the use of the curriculum materials.

Students' assessment of industry's contribution to interns' training was very encouraging. Interns were given the opportunity to serve in different sections of the industry, industry workers were friendly and prepared to assist in the training of interns. These indices of successful internship were the result of guidance (stakeholders' roles specified in curriculum materials), which is corroborated in the work by Crossley et al. (2007) and Beggs et al. (2008). The self-assessed competencies of students who embarked on an internship (*trained*) were higher than those who did not (*untrained*). Moreover, trained students and industry personnel were quite satisfied with their activities during internship. Paradoxically, industry personnel were more satisfied with interns' job performance during the internship than their teachers were.

Guided internship is paramount, especially in polytechnic education, whose mandate is to equip its students with hands-on experience, so that internship is not a peripheral programme, but core. The introduction of CCD in design teams, a bottom-up approach to curriculum development, is a new concept in the Ghanaian polytechnics, but holds great promise in bringing about some fundamental changes that could promote content knowledge as well as the collaborative skills of teachers, and could eventually assert the polytechnic's position as a tertiary institution where curricula is not imposed by an external body (Van den Akker, 2003). The tremendous contribution of tourism and the hospitality industry to the world's economy should encourage institutions of higher learning to encourage CCD in design teams, so as to design appropriate curriculum that serves the interests of all stakeholders.

Second Study

The main research question framing the study is: *Do the curriculum materials produced by the design teams contribute to a renewed student internship programme, according to the stakeholders involved?*

Designing Curriculum

To draw out suggestions for the improvement of the internship programme, teachers, students and industry personnel were first informed about the existing problems with student internships in Ghana's polytechnics (Akomaning et al., 2011). After that, two teams of the HCIM teachers at Takoradi Polytechnic, eight in each group, were formed to collaboratively design curriculum materials for the student internship. One team developed resource materials in food production and food and beverage, while the other designed materials/resources for accommodations and front office operation. The curriculum materials had the following components: rationale specifying the distinctive roles of teachers, students and industry personnel, content description of the four core areas of the hospitality industry, practical activities the students had to carry out during internship, job rotation and meaningful jobs assigned during internship and student supervision from teachers and industry personnel. Copies of the final document were made and distributed to all stakeholders before the commencement of internships in 50 hotels. During the student internships, the Industrial Liaison Officer (ILO) and teachers were expected to supervise the students.

Methods

Participants

Sixteen out of 22 HCIM teachers participated in two design teams. Six of them had previous experience in curriculum development. The ILO participated in the study because he played a pivotal role in the organisation of internships and is the link between the polytechnic and industry. Fifty organisations where students were placed for their internship also took part in the study. A total of 165 first-year (n = 104) and second-year (n = 61) students took part in the workshops at the start of the intervention. One hundred and forty-three (students available at the time of administering the questionnaire) out of the 165 students participated in the data collection at the end of the design process. Of those 143, 89 and 54 were first- and second-year students, respectively.

Research Instrumentation

Student Instruments

A focus group discussion (FGD) with students addressed suggestions for improvement of the internships. Two questionnaires were administered to students. The first was administered after the FGDs. It had two parts: the first part was based on year groups. The second part centred on student self-assessment of their competencies in the four core domains in the hospitality management programme. The questionnaires included predominantly closed-ended statements with responses on a five-point Likert scale and five open-ended questions. The second questionnaire, similar to the first, was administered immediately after the internship 6 months later. The open-ended questions focused on year group, place of first and second internships and duration. Others asked about the sections of industry where the student had trained, and a brief description of competencies acquired in the recent internship. The close-ended statements were similar to the first questionnaire except for additions related to employers' satisfaction with job performance and assessment of the curriculum materials.

Teacher Questionnaires and Interview

Two questionnaires were administered to teachers. The first was administered immediately after the workshops. The rationale was to elicit background information on teacher experience in curriculum design activities (open-ended questions) and the teachers' collaborative skills related to ensuring high quality design (closed-ended statements). In addition, both the teacher questionnaire and interview addressed the practical use of the curriculum. There were also statements on institutional support regarding the polytechnic's link with industry, prior contact with industry before students went to their internships and the polytechnic's inquiries about places for students for internship. Finally, there were an open-ended question and closed-ended statements addressing supervision of students during internship by teachers and industry-based supervisors.

ILO Interview

The ILO was interviewed before and after the internship concerning implementation of the internship, supervision, challenges, practical use of the curriculum materials on internship, teacher roles, and the polytechnic's contribution to the internship.

Industry Personnel Questionnaires and Interview

Personnel at all of the 50 workplaces visited were given the curriculum materials and questionnaire at the start of the study. Forty-one out of the 50 responded to the questionnaire (82%). Five were interviewed at the start of the study regarding challenges and suggestions for improvement in the student internship programme. The first questionnaire given to industry personnel was mainly a closed-ended five-point Likert scale type on the practical use of curriculum materials, with five open-ended questions. Industry personnel assessed students' competencies during the internship (second questionnaire, from students' logbooks on the use of curriculum materials) with a rating scale of 1–5 representing weak and outstanding, respectively, and a statement from the first questionnaire on whether employers are satisfied with students' job performance sought to address the research question. Formalisation of the polytechnic-industry link and whether the polytechnic made prior contacts with industry before students came to the internship while the polytechnic looked for places for students to practice were statements on institutional support for the internship programme. Administration of this instrument was done after personnel were briefed on the curriculum materials. Retrieval of the instrument was carried out by the interns after the internship.

Checklist and Researcher Logbook

This instrument (checklist) was used to collect data during visits by the researcher to students in the hotel industry. The purpose was to know first-hand the interns' situation and to interact with personnel at the organisations concerning the interns' general behaviour. Student assigned roles, industry training, working environment, industry supervision, teacher supervision, competencies expected and competencies achieved were the indices being investigated. In all, 89 interns were visited at 50 hotels. The researcher's logbook captured the initial arrangements for workshops for the ILO, teachers, students and industry representatives, and design process for the curriculum materials.

Main Findings

This study focused on collaborative design of curriculum materials by teacher teams, with input by students and industry representatives, which were used during student internship to address the challenges of implementing this programme. The teachers ensured high quality in terms of consistency, practicality and effectiveness in the design process for the curriculum materials, by their training and experience. Teachers, students and industry personnel concurred with the practical usefulness of the curriculum materials in the training of students. The subsequent outcomes of student self-assessed competencies and industry-based assessment appear to be commendable. Stakeholders acknowledge that the curriculum materials serve as a guide to students' training, providing knowledge to both industry personnel and students as to what roles are expected of them. Internship practices improved in the areas of supervision, workers cooperating with interns, job rotation, and work assigned to interns. However, other significant improvements, which include the duration of the internship, placement and participation of interns could be traced to the improvement in the polytechnic-industry link/relationship.

The collaboration among teachers, with input from students and industry personnel, in the design of the curriculum materials, and the support of the polytechnic had positive effects on the organisation of the internship programme, culminating in improved internship practices and student competencies. This study is comparable to that by Cecil, Fu, and Jones (2010), who contended that stakeholders were fairly satisfied with the curriculum designed to improve student competencies because stakeholders had their roles defined and the material was equally usable. Another study by Ko (2008), in which stakeholders' contribution to the hospitality internship curriculum gave rise to interns' satisfaction with the internships and the perception of the curriculum as practical and useful is consonant with the findings of this study. This research shows that teachers were also satisfied with the polytechnic's prior contacts with industry before students were sent out for internship, but students held a contrary view. Notably, the role of the teacher in the design and use of curriculum material, regardless of where it is applied, cannot be over-emphasised. If it will cost the polytechnic more funds than it can bear, the polytechnic can devise other alternative ways of ensuring some form of monitoring without necessarily visiting industry sites. Generally, there was improvement on the part of all stakeholders. However, the polytechnic should endeavour to enroll more teachers in the internship supervision team and should continue to improve its collaboration with industry.

Overall Conclusions

The student internship programme is a critical component of the HCIM programme of polytechnics in Ghana. However, it was unstructured and therefore was fraught with several implementation challenges such as lack of curriculum materials to guide the programme, sporadic link between the polytechnic and industry, and some students not being placed for internship, as well as some teachers not getting the opportunity to participate in internship supervision. It is refreshing to note that the outcomes of these studies suggest a marked improvement in internship practices.

Collaborative curriculum design (CCD) in design teams was adopted as an approach for the project in these studies. This approach gave teachers the opportunity to design curriculum materials to help guide the organisation of student internships with input from industry personnel and students. Besides the crafting of the curriculum materials, the approach created a platform for teachers to collaborate and to generate ideas, and thereby promoted teacher professional development.

Management support is paramount for the successful execution of student internships. Both studies recorded general improvements in internship practices; however, some of the students at Tamale (first study) could not do internships and teachers could not supervise students during internships. The same cannot be said about Takoradi Polytechnic (second study), where teachers were involved in supervision and all students had the opportunity to intern. The discrepancy could be due to the fact that the former had a student internship programme that was less structured and management support was minimal.

Reflections

Importance of the Context and Needs Analysis

The implementation challenges emerged out of the context and needs analysis study (Akomaning et al., 2011) that informed the industrial liaison officers, teachers, students and industry personnel (key stakeholders) of the hospitality management programme. Following this awareness creation, the stakeholders, particularly the teachers, expressed the need for well-thought-out curriculum documents to be designed to help streamline the student internship experience. The need to design curriculum documents therefore prompted the adoption of collaborative curriculum design in design teams as a bottom-up approach feasible for addressing the implementation challenges.

Collaborative Curriculum Design: Necessary Conditions

Capacity has been identified as one of the missing links in the organisation of student internship programmes in Ghana's polytechnics. In the context of student internships, the description of student internship was unstructured and faced with challenges. Hence, the expected mandated functions or roles of teachers, students and industry personnel were not efficiently and effectively executed. In view of this, the research sought to address the challenges by adopting collaborative curriculum design as a bottom-up approach to empowering teachers in the Departments of HCIM to design curriculum materials in order to support the activities of student internship. The functionality of collaborative curriculum design in design teams depends on whether the conditions for *working in teams* are in place and on how the management of the educational institutions lends support to their activities.

High Quality Curriculum Materials for Improved Internship Practices

The materials had a clear-cut rationale indicating that hospitality industry staff should endeavour to guide students during internships by ensuring that students served in all the sections of the industry and assigning them to meaningful and challenging tasks with the intent of better preparing students to transition smoothly from school to work. The objectives of the student internships were made explicit; the content of the curriculum materials was departmentalised into four areas, taking account of the students' grade levels. A clear definition of the roles of stakeholders (students, teachers and industry personnel) was important in the materials.

The contributions made by other stakeholders (students and industry representatives) during the design of the curriculum materials and the systematic arrangement of the components of the curriculum documents by design teams led to appreciation and easy application of the documents during internship by these stakeholders. In this regard, the outcomes of this research were consonant with the study by Kessels and Plomp (1999) on ensuring curriculum quality through a "systematic relational approach" that attends to internal and external consistency. In the studies reported in this chapter, an explicit rationale in relation to a clear distinction between the expected roles of polytechnic teachers, industry representatives and students was important. Coherence between content, objectives, activities and assessment was also crucial for the internal consistency of the materials and improved internship practices.

Ownership and Sustainability

An additional aim of this research project was to ensure that after the design and implementation phases, the reform would continue in the educational institutions. Hence, the quest for active involvement by participants (students, teachers, industry personnel and management representatives) in the various stages of the project was paramount. By so doing, they would not perceive the reform as an imposition from outside, but would take pride in what they had been able to execute. Thus, ownership, a critical component of educational reform, would be internalised by stakeholders. Claiming the products as theirs would facilitate implementation, and plausible positive outcomes would encourage stakeholders to sustain and even improve on the implementation of the reform in practice.

Currently, the polytechnics in Ghana as tertiary educational institutions have not weaned themselves completely from a regulatory body such as NABPTEX, the institute coordinating activities in curriculum design and development in the polytechnics. If collaborative curriculum design in design teams is given the needed support from all fronts (management, teachers, students and industry personnel), the functionality of its operations would be mutually beneficial for the key stakeholders in particular and the nation in general. Finally, Ghana stands to benefit immensely if personnel for the tourism and hospitality industry are better prepared for their jobs. The issue of graduate unemployment, which is of grave concern to the nation, could be greatly minimised through renewed student internships, because in this way students would be equipped with the competencies needed for employment or setting up their own business enterprises.

References

Akomaning, E., Voogt, J. M., & Pieters, J. M. (2011). Internship in vocational education and training: Stakeholders' perceptions of its organisation. *Journal of Vocational and Training, 63*(4), 575–592.

Bakar, M. J. A., Harun, R. J., Yusof, K., & Tahir, I. M. (2011). Business and accounting students' perceptions on industrial internship program. *Journal of Education and Vocational Research, 1*(3), 72–79.

Barber, L. K., & Bailey, S. F. (2015). *Internship supervision resources for developing student employability*. DeKalb, IL: Northern Illinois University.

Beggs, B., Ross, C. M., & Goodwin, B. (2008). A comparison of student and practitioner perspectives of the travel and tourism internship. *Journal of Hospitality, Leisure, Sport and Tourism Education, 7*(1), 31–39.

Beggs, B. A., Ross, C. M., & Knapp, J. S. (2006). Internships in leisure services: An analysis of student and practitioner perceptions and expectations. *Schole, 21*, 1–20.

Blackwell, P. (2003). Developing departments. In P. Blackwell & P. Blackmore (Eds.), *Towards strategic staff development in higher education* (pp. 119–130). Buckingham, UK: SRHE/Open University Press.

Blokhuis, F. T. L., & Nijhof, W. J. (2008). Evidence-based design of workplace learning. In W. J. Nijhof & L. F. M. Nieuwenhuis (Eds.), *The learning potential of the workplace* (pp. 163–180). Rotterdam, The Netherlands: Sense Publishers.

Cecil, A. K., Fu, Y., & Jones, E. (2010). *Monitoring student success: A systemic model for hospitality and tourism education*. International CHRIE Conference-Refereed Track. Paper 10.

Center for Careers, Life, and Service. (2014). *Student internship handbook: A guide for students participating in a Grinnell college affiliated internship experience*. Grinnell, IA: Center for Careers, Life, and Service.

Clark, G., & Whitelegg, J. (1998). Maximising the benefits from work-based learning: The effectiveness of environmental audits. *Journal of Geography in Higher Education, 22*, 325–334.

Cook, S. J., Parker, R. S., & Pettijohn, C. E. (2004). The perceptions of interns: A longitudinal case study. *Journal of Education for Business, 79*(3), 179–185.

Crossley, J. C., Jamieson, L. M., & Brayley, R. E. (2007). *Introduction to commercial recreation and tourism: An entrepreneurial approach* (5th ed.). Champaign, IL: Sagamore Publishing.

Dee, J. R., Henkin, A. B., & Singleton, C. A. (2006). Organizational commitment of teachers in urban schools: Examining the effects of team structures. *Urban Education, 41*, 603–627.

Deketelaere, A., & Kelchtermans, G. (1996). Collaborative curriculum development: An encounter of different professional knowledge systems. *Teachers and Teaching: Theory and Practice, 2*(1), 71–85.

Denton, J. W., Kleist, V. F., & Surendra, N. (2005). Curriculum and course design: A new approach using quality function deployment. *Journal of Education for Business, 81*(2), 111–117.

Dixon, M. A., Cunningham, G. B., Sagas, M., Turner, B. A., & Kent, A. (2005). Challenge is key: An investigation of affective organizational commitment in undergraduate interns. *Journal of Education for Business, 80*(3), 172–180.

Domask, J. J. (2007). Achieving goals in higher education: An experiential approach to sustainability studies. *International Journal of Sustainability in Higher Education, 8*(1), 53–68.

Doyle, W., & Ponder, G. A. (1975). The practicality ethic in teacher decision-making. *Interchange, 8*(3), 1–12.

Effah, P. (2005). A decade of polytechnic education in Ghana: An assessment of achievements and failures. *Proceedings of the First Sunyani Polytechnic Lecture Series, 1*, 17–29.

Fullan, M. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Gervedink Nijhuis, C., Bakah, M. A. B., & Akomaning, E. (2009). Leadership challenges involved in managing institutional and curriculum changes in polytechnics. In W. Kouwenhoven, G. Oduro, & K. Nsiah-Gyabaah (Eds.), *Trends in polytechnic education in Ghana* (pp. 85–100). Amsterdam, The Netherlands: Vrije Universiteit.

Gillim, M. (2006). *Putting the pieces together: Effective characteristics of an HR internship program* (Senior Honors Theses, Paper 60). Eastern Michigan University.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams* (Doctoral dissertation). Enschede, The Netherlands: University of Twente.

Hargreaves, A. (2003). *Teaching in the knowledge society. Education in the age of insecurity*. New York: Teachers College Press.

Hasbullah, H., & Sulaiman, S. (2002, August). *Industrial internship programme at University Technology Petronas – A collaboration strategy that enhanced students' soft skills in the ever-changing technology*. A paper presented at International Conference on Engineering Education, Manchester, UK.

Hattie, J. (2003, October). *Teachers make a difference: What is the research evidence*? Paper presented at the Australian Council for Educational Research Annual Conference on Building Teacher Quality, Melbourne, Australia.

Havnes, A. (2009). Talk, planning and decision-making in interdisciplinary teacher teams: A case study. *Teachers and Teaching, 15*(1), 155–176.

Heath, R. R. (2010). Ensuring preservice teachers' readiness to teacher standard-based curricula. *North Carolina Middle School Association Journal, 2*(25), 1–9.

Heppell, M. (2004). *How to be brilliant*. London: Pearson-Prentice Hall.

Kessels, J., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709.

Ko, W. (2008). Training, satisfaction with internship programs, and confidence about future careers among hospitality students. *Journal of Teaching in Travel & Tourism, 7*(4), 1–15.

Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., et al. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting learning by design (TM) into practice. *Journal of the Learning Sciences, 12*(4), 495–547.

Lam, T., & Ching, L. (2006). An exploratory study of an internship program: The case of Hong Kong students. *Hospital Management, 26*, 336–351.

Lewis, A. (2004, December). *Rationalising a tourism curriculum for sustainable tourism development in small Island States: A stakeholder perspective*. Paper presented at a conference on Critical Issues in Tourism Education of the Association for Tourism in Higher Education, Missenden Abbey, Buckinghamshire, UK.

Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.

McManus, A., & Feinstein, A. H. (2008). Internships and occupational socialization: What are students learning? *Developments in Business Simulation and Experiential Learning, 35*, 128–137.

Nieveen, N. (2009). Formative evaluation in educational design research. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research* (pp. 89–101). Enschede, The Netherlands: Axis Media-ontwerpers.

Riordan, G. (2001). Teachers working together. *The Practising Administrator, 23*(1), 6–10.

Rock, T. C., & Wilson, C. (2005). Improving teaching through lesson study. *Teacher Education Quarterly, 32*(1), 77–92.
Rothman, M. (2007). Lessons learned: Advice to employers from interns. *Journal of Education for business, 52*(3), 140–144.
Sackney, L., Mitchell, C., & Walker, K. (2005). *Building capacity for learning communities: A case study of fifteen successful schools*. Paper presented at the American Education Research Association annual meeting.
Scribner, J. P., Sawyer, R. K., Watson, S. T., & Myers, V. L. (2007). Teacher teams and distributed leadership: A study of group discourse and collaboration. *Educational Administration Quarterly, 43*(1), 67–100.
Simmie, G. M. (2007). Teacher design teams (TDTs) – building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies, 26*(2), 163–176.
Thiel, G. R., & Hartley, N. T. (1997). Cooperative education: A natural synergy between business and academia. *SAM Advanced Management Journal, 62*(3), 19–24.
Van den Akker, J. J. H. (2003). Curriculum perspectives: An introduction. In J. J. H. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.
Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*, 1235–1244.
Waddoups, G. L., Wentworth, N., & Earle, R. (2004). Principles of technology integration and curriculum development: A faculty design team approach. *Computers in the Schools, 21*(1/2), 15–23.
Walo, M. (2001). Assessing the contribution of internship in developing Australian tourism and hospitality students' management competencies. *Asia-Pacific Journal of Cooperative Education, 2*(1), 21–28.
Wilson, P. H., Strutton, D., & Farris II, M. T. (2002). Investigating the perceptual aspect of sales training. *The Journal of Personal Selling & Sales Management, 22*(2), 77–111.
Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.
Youth Forum Jeunesse. (2009). *Opinion paper on internships*. Adopted by the Council of Members/Extraordinary General Assembly: Brussels, Belgium, 8–9 May 2009.

Chapter 16
Tracing Teachers' Professional Growth from Updating Polytechnic Courses in Design Teams

Marie A. B. Bakah

Introduction

Effective professional development of teachers is positively related to learning at the workplace, not only individually through classroom practices but also through collegial interaction and collaboration (Billett, 2009; Hoekstra, Beijaard, Brekelmans, & Korthagen, 2007; Tynjälä, 2008). Research on workplace learning shows that when people work alongside others, they observe, listen and participate in activities; this enables them to learn new practices and perspectives as well as to gain expertise (Eraut, 2007). According to Eraut (2007), the quantity and quality of learning among professionals can be enhanced by increasing opportunities to consult with and work alongside others in teams or temporary groups. In the educational research literature about teacher learning, communities of practice are considered important as settings for on-going teacher learning at the workplace that eventually aims to improve teaching practice and students' outcomes (Grossman, Wineburg, & Woolworth, 2001; Hord, 2004; Little, 2003). According to Wenger (2003), a 'community of practice' is a kind of grouping with three elements: mutual engagement in the task at hand; common negotiation of the focus of work; and development of a shared repertoire of knowledge and skills to effectively address work demands. Collaboration in teams or communities of practice is presented as an effective response to increasing change and as creating a knowledge-based workforce. One characteristic of communities of practice is teacher collaboration in small groups who (re-)design parts of the curriculum (e.g., courses, lesson activities). In this study, collaborative curriculum design in teams was considered to be a workable, cohesive strategy for effective professional development (cf. Burrell,

M. A. B. Bakah (✉)
Institute for Educational Planning & Administration, University of Cape Coast, Cape Coast, Ghana
e-mail: mbakah@ucc.edu.gh

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_16

Cavanagh, Young, & Carter, 2015; Millar, Leach, Osborne, & Ratcliffe, 2006; Nieveen, Handelzalts, Van den Akker, & Homminga, 2005; Simmie, 2007). The study focuses on teacher learning in curriculum design teams and aims to identify effective learning and development processes in these teacher teams while they (re-) design their courses. The study is part of a body of on-going research on teacher professional growth and collaborative curriculum design (e.g., Bakah, Voogt, & Pieters, 2012b; Handelzalts, 2009; Voogt et al., 2011).

Teachers' Learning and Collaborative Curriculum Design

Collaborative curriculum design is gradually gaining attention in education as a teacher professional development strategy and as a way to develop teacher ownership of curriculum innovation (Desimone, 2011; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Voogt et al., 2011). In the present study, polytechnic teachers collaboratively re-designed their curriculum in teacher design teams. A design team is defined as a group of at least two teachers, from the same or related subjects, working together on a regular basis, with the shared goal of redesigning and implementing (a part of) their common curriculum (Handelzalts, 2009). The design team concept provides teachers with a creative space to reconsider the teaching of their subject, the intellectual stimulus of working together, and the challenge to move their thinking forward; in this way, teachers are invited to become curriculum makers (Clandinin & Connelly, 1992; Simmie, 2007). Designing in teams is one current popular means by which teachers can collectively participate in curriculum design and fulfil their learning, social and intellectual needs. In fact, collaborative design has been identified as effective in bringing about teacher professional development (Borko, 2004; Deketelaere & Kelchtermans, 1996; Nieveen et al., 2005; Penuel, Riel, Krause, & Frank, 2009). A review of research on teacher design teams showed that design teams in which teachers collaboratively (re-)design a new curriculum, and also implement their design in their educational practice, contributed not only to the learning of individual teachers but also to improved classroom practice and student outcomes (Voogt et al., 2011).

For teachers, learning occurs in many situations in their practice (Peressini, Borko, Romagnano, Knuth, & Willis, 2004) and can be conceived from a cognitive and situative perspective. Whereas the cognitive perspective sees learning as a product, a change in the beliefs, knowledge and skills of individuals (Alexander, Schallert, & Reynolds, 2009), the situative perspective focuses on learning as a process that is fostered by interaction with the practices in which individuals participate. In the situative perspective, it is important to consider "individuals' acquisition and use of knowledge as aspects of their participation in social practices" (Greeno, 2003, p. 315). In addition, situated learning refers to how a person learns a particular set of knowledge and skills, assuming that the situation in which a person learns is a fundamental part of what is learned (Greeno, Collins, & Resnick, 1996). In sum, the situative perspective indicates that to trace teacher learning, we must take into account both the individual teacher-learners and the physical and social systems in which they are participants (Putnam & Borko, 2000).

In this study, teachers' learning in design teams is viewed within both the situative and the cognitive perspectives. The professional development programme provided teachers with the opportunity to acquire knowledge in their respective subject domains, which can be classified under the cognitive perspective on teacher learning. In addition, the occurrence of situated learning among teachers is envisaged, due to the (re-)design of their courses in design teams and the implementation of the updated courses in try-outs. Individual teachers are particularly expected to learn from those practices insofar as such practices relate to their career. When professional development is organized in a collective manner, teachers share successful experiences and learn from each other (Gallagher & Ford, 2002). Through this approach, teachers utilize the instructional resources and skills of their peers to support their professional development and attainment of shared instructional and curricular goals (Glazer & Hannafin, 2006). To advance curriculum design teams as a teacher professional development strategy, this study argues for the importance of better understanding about how teachers make sense of their learning in teacher design teams. Specifically, this study documents the process of teacher professional development among polytechnic teachers who collaboratively redesigned their courses and conducted classroom try-outs of the updated courses.

The Interconnected Model of Professional Growth

In this study, the Interconnected Model of Professional Growth (IMPG) propounded by Clarke and Hollingsworth (2002) is used to identify learning processes that are fostered by teacher design teams aiming to (re-)design part of their curriculum (Coenders, Terlouw, Dijkstra, & Pieters, 2010; Voogt et al., 2011). The IMPG Model (see Fig. 16.1) is an empirically grounded model for investigating teacher learning. The IMPG distinguishes four separate domains in which change in teachers can take place. Three of these domains are part of teachers' professional life and may result in teacher change. The *Personal domain* reflects teacher's knowledge, beliefs and attitudes; when teachers acquire new knowledge and skills or develop new attitudes, change in this domain occurs. The *Domain of practice* encompasses teacher learning that is situated in all forms of professional experimentation (not exclusive to classroom experimentation). In this study, change in the domain of practice is concerned with teachers' (re-)design of their course in design teams and the implementation of the updated courses in classroom try-outs. The *Domain of consequence* concerns the outcomes of teaching for students. In this study, change in the domain of consequences occurs when teachers perceive the outcomes of the classroom try-outs as salient. The fourth domain, the *External domain*, is external to the teacher and deals with sources of information and other stimuli that support and facilitate change. Through the External domain, teachers become acquainted with new ideas, practices and/or strategies that are introduced and developed by others. In the

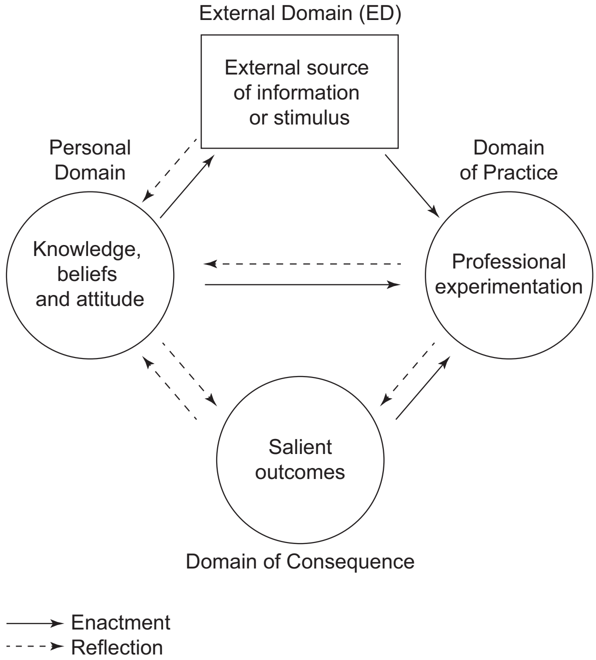


Fig. 16.1 The interconnected model of professional growth (Clarke & Hollingsworth, 2002)

present study, this refers to participation in a workshop and visits to industry sites. The model suggests that change in one domain is translated into growth in another through the mediating processes of "reflection" and "enactment". Reflection refers to teachers' thinking about their practice ('reflection on action') and during practice ('reflection in action') (Schön, 1987). Enactment in this study refers to the re-design and implementation of the polytechnic courses.

The mediating processes of reflection and enactment are represented as arrows linking the domains. The IMPG recognizes the complexity of professional growth through the identification of multiple growth pathways between the domains. Unique to this model is its depiction of professional growth as an inevitable and continuing process of learning, recognizing the mediating processes of reflection and enactment as the mechanisms by which change in one domain leads to change in another (Clarke & Hollingsworth, 2002). The interrelated nature of the four domains emphasises the complex nature of teacher professional growth and provides important considerations for teacher professional development. From this perspective, these four domains together constitute a teacher's situated learning environment.

On the basis of the features of IMPG, teacher professional growth is investigated in this study as guided by the following research question: *How does teacher participation in (re-)design and implementation of polytechnic courses in teams impact their professional growth?* In this investigation, teacher professional growth is defined as positive change taking place in teachers' knowledge, attitudes and skills (cf. Brown, Collins, & Duguid, 1989; Resnick, 1987).

Context of the Study

In 1993, the ten state-owned vocationally-oriented polytechnics in Ghana were upgraded to tertiary status to offer career-focused programmes in various domains. The tertiary status of the polytechnics became critical when the polytechnics were mandated to offer Bachelor of Technology degree programmes in 2007. Stakeholders then became concerned about whether the existing human and material resources of the polytechnic were adequate for the effective functioning of those institutions (Nsiah-Gyabaah, 2005). Although the original curriculum of the polytechnics was designed to cater for the human resource needs of industries, continuous update and evaluation of content are needed in order to meet the challenges faced by industries. In addition, studies have shown that polytechnic teachers in Ghana need to improve their knowledge and skills to match the tertiary status of the polytechnics (Gervedink Nijhuis, Bakah, & Akomaning, 2009; Nsiah-Gyabaah, 2005). The intervention in this study is part of multiple efforts to step up professional development for polytechnic teachers in the context of a curriculum reform initiative in Ghana.

A study by Bakah, Voogt, and Pieters (2012a) about polytechnic teachers' professional development needs revealed that teachers wanted to improve their knowledge and skills through industrial attachment. Industrial attachment is seen as an effective professional development activity for polytechnic engineering teachers to keep their vocational knowledge and expertise current, including their knowledge of technologies and practices commonly used in contemporary workplaces (Loveder, 2005). Bakah et al. (2012a) concluded that as a result of technological advancements, polytechnic engineering teachers saw the need to pursue relevant knowledge to improve their professional competence and be able to update their courses.

Based on the findings of Bakah et al. (2012b), curriculum design teams were adopted as a teacher professional development strategy at a polytechnic in Ghana. Teacher participation in curriculum design teams was organized as an intervention that lasted 14 weeks in total. The intervention included an introductory workshop, collaborative curriculum design activities to update engineering courses, industrial site visits by the design teams and implementation of the updated courses in classroom try-outs. The introductory workshop, which was held in the first week, included orientation for the teachers regarding curriculum design in design teams. The author was the main facilitator at the workshop and throughout the study. Starting from the second week, three teams of teachers, based on commonality of their subject areas, worked collaboratively to update their courses to suit current technological practices in industry. The teachers also visited industry sites in teams to acquire relevant information to make their courses more practical and relevant in content. In these visits they were also exposed to several technologies relevant to their area of study. For the most part, the teams worked at their own pace to complete the redesign of their courses. During the thirteenth and fourteenth weeks, teachers conducted classroom try-outs of the updated courses they had collaboratively designed in teams. The topics for the try-outs varied from programme to programme.

Methods

Design

This study employed qualitative methods for data collection and analysis in a multiple case study (Yin, 2003). The three cases were the three teacher design teams in the Production, Automobile and Electrical Departments of the Faculty of Mechanical Engineering at the Polytechnic in Ghana. Teachers in the three teams were the units of analysis.

Participants

Data for the study came from three design teams made up of male teachers from the Faculty of Engineering at a polytechnic that was selected because of its longevity and proximity to some major industries. The teachers worked in the Higher National Diploma (HND) programmes in Automotive Engineering (five teachers), Production Engineering (five teachers) and Electrical Engineering (six teachers). For the purpose of reporting on individual teacher professional growth, in the present study the sample was limited to six teachers (two selected from each team, based on longest and shortest years of service at the polytechnic). Background particulars for the teachers involved in this study (pseudonyms used) are presented in Table 16.1.

Data Collection

Two types of data were collected from teachers: (1) detailed field notes (in logbook) taken from group discussions in design activities, and (2) five face-to-face interviews on self-progress conducted throughout the study. There were five categories of semi-structured interview data collected from each teacher to find out about their experiences during the following team activities: industry site visits, collaborative design activities, teaching tryouts, perceptions of teamwork and teacher learning in teams. On average, each of the five interviews lasted 25 min, making the total interview time per teacher approximately 2 h and 5 min.

Data Analysis

All interviews were transcribed and coded using codes generated from the study. The Atlas-ti qualitative data analysis software (version 6.2) was used to code and analyse all the interview data. The communications in the transcriptions were

Table 16.1 Background particulars for teachers

Team	Teacher (pseudonyms)	Age	Highest academic standing	Years of teaching in polytechnic	Course	No. of students
Automotive	Melvin	54	Diploma	15	Workshop Process and Practice 1	18
	Julian	46	Master's	1	Hydraulics 2	93
Electrical	Steve	64	Diploma	17	Electrical Machines 3	71
	Harry	26	Bachelor's	2	Electrical Machines 1	81
Production	Ernest	69	Bachelor's	21	Manufacturing Technology 2	49
	Leonard	38	Master's	3	Engineering Processes 2	58

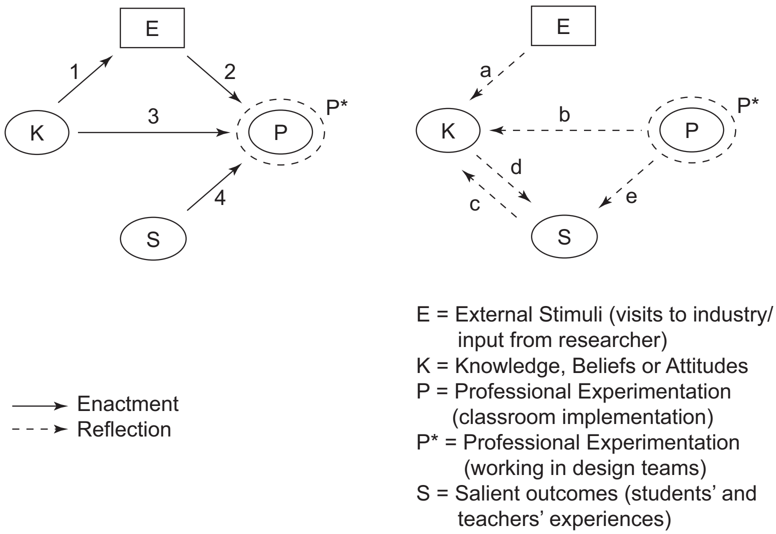


Fig. 16.2 Teacher learning networks

identified and coded using the deductive method of coding (Miles & Huberman, 1994). The codes developed were based on Fig. 16.2.

Two aspects of the domain of practice are distinguished in this analysis. P is used for activities related to teacher implementation of the re-designed courses, while P∗ is used for the design activities teachers conducted in the teams. Table 16.2 provides examples of codes based on the IMPG Model and the type of actions taken.

After all transcripts had been coded, the data were analysed either to describe the target variable(s), or to identify relationships between variables. The idea behind this was to establish the focus of the conversations between the participants when in

Table 16.2 Examples of deductive coding of the summaries

Code	IPMG model feature on which code is based	Example of action
Industrial attachment evaluation	E-External stimuli	Visits to industry
Course update evaluation	P∗ – Professional experimentation	Working in design team
Teaching tryout appraisal	P- Professional experimentation	Classroom implementation
Perceptions of design teams	S – Salient outcomes	Teachers' experiences
Teacher learning	K – Knowledge, beliefs or attitudes	Learning in design teams

the design teams, during their classroom interactions with students, and between the participants and the researcher. Inter-coder reliability (Neuendorf, 2002) of two coders was calculated using a random sample of 18 out of 30 interviews from 6 teachers, with an overall agreement of .89 (Cohen's κ). The method used for the analysis of the field note data was content analysis for the systematic description of the text. Major themes were identified and clustered (Miles & Huberman, 1994) based on the five categories of codes listed in Table 16.2.

Findings

In the ensuing sections, the reflection and enactment processes of the six teachers in the Automotive Engineering, Electrical Engineering and Production Engineering design teams, respectively, are presented (Fig. 16.2 identifies the coded elements of teacher learning networks that are included). This is followed by the growth paths that were identified through our analysis.

Individual Learning in Teams

Automotive Engineering Team

Melvin

During the development process, Melvin expressed optimism at advancing in knowledge in his subject area *(1)*. He hoped to improve his course but had never thought that working in a team could be practical for achieving this purpose. Commenting on his knowledge of course design, Melvin stated:

> I learnt the technicalities involved such as analysing the course structure *(b, P*)*. Collectively digesting the syllabus was so practical *(e, P*)*.

Melvin practiced the procedures of course design in a communal effort *(3, P*)*. Having been equipped with information from industry, Melvin's knowledge had been enhanced *(a)*, as he stated that:

> At Mechanical Lloyd, I discovered their latest diagnostic tool for BMW vehicles and practiced it on a BMW 7-Series (a).

Melvin's acquisition of such knowledge enabled him to update his course *(3, P*)* and conduct his teaching tryout *(3, P)*. Melvin taught *On Board Diagnostics;* commenting on his teaching, he said:

> There are a lot of things I read and teach in the abstract, but things I encountered at the industry have helped me *(a; 2, P)*. It's going to enhance my teaching and make it easier to explain things to my students *(a, 3, b)*. I understood the diagnostic system and was able to relay the information to my students better *(a; 3, P; b, P)*. It was a lively class as students discussed fault-finding in their groups *(e, P)*.

Reflecting on his involvement in teamwork, Melvin revealed that:

> I had the opportunity to interact with fellow teachers and learnt to tolerate diverse behaviours *(e, P*)*... It has been a lot of learning experience to listen to colleagues' ideas *(b, P*)*.

Julian

Having spent a year at the polytechnic, Julian expressed enthusiasm about visiting industry sites with his colleagues *(1)*. He had high expectations of older and more experienced colleagues in terms of drawing from their experiences with their courses and their ideas for course design *(b, P*)*. Just like others in his team, he got involved in the course update, and said:

> We all came to agreement that there was a need for a particular type of students' practical training, which was an important activity *(3, P*)*. I learnt from my colleagues certain competencies that students need to possess as well as the need for a balance between technical and industry-specific skills *(b, P*)*. It intensified my practical knowhow *(a)* and gave me ideas for the direction of my course update *(3)*.

Julian visited industry sites in the company of other colleagues and stated that:

> After undergoing servicing, the amount of pressure for the machine to operate on is calibrated on the computer; this actually broadened my understanding about the latest way of testing hydraulics of heavy-duty trucks *(a)*.

Due to the knowledge acquired, he was able to update his course *(3, P*)*. During the teaching tryout by Julian, he used pictures in PowerPoint to explain the maintenance of *Hydraulic Systems*. Commenting on the teaching, he said:

> As we haven't got the physical components of these off-road trucks, we can now show them pictures of those components *(3, P)* rather than allowing them to just imagine as in previous lessons. I could see their interest in the lesson *(e, P)*.

Julian recognised the influence of teamwork on his knowledge as depicted in his statement:

> It is very beneficial to work in a team because we share ideas about what we do and what we need to do *(b, P*; 3, P*)*. I discovered the mode of presenting the topic with colleagues' help *(b, P*)* and it was successful *(e, P)*.

Electrical Engineering Team

Steve

Steve had been involved in the development of courses at the national level, but had no experience in developing courses using information from industry on current technologies and so was curious. Having paid a visit to an industry site, this is what Steve had to say:

> …I got to know that the voltages used for excitation at the turbo generators were far less than at the hydro-generating stations *(a)*. In the hydro-generating stations, about 500VDC is being applied whereas turbo generators at thermal power stations have about 35VDC ... the range is very vast. All along, I thought they were injecting about 100VDC so 35V was shocking *(a)*. Then the principle I knew came to the fore and makes me appreciate N∗I as magnetomotive force, giving me a clearer picture of that mathematical expression *(1; a)*. I got to know what excitations mean *(a)*.

Pondering over the redesign of the course, Steve pointed out that:

> We identified some learning needs to bridge the gap between our syllabus and industry competency standards *(2, P*)* and I discovered that as a technical and vocational teacher, I cannot create situational learning experiences without an understanding of workplace contexts and changes *(1; b, P*)*. Such understanding made me draw on some practical knowledge from the industry visit *(b, P*; a; 2, P*)*.

These observations by Steve further reveal that his discoveries during course design added to his knowledge *(b, P*)*. Having taught *Synchronisation*, Steve reflected on the lesson and new additions to the courses and students' reactions to the classes they took. He articulated:

> If you should have a look at the course outline for Electrical Machines 3, it's really abstract and complex … for there are some things that one cannot appreciate until a field experience *(2, P; 1)*. For instance when you talk about an exciter or armature reaction to students in class, they can't visualise it. But with that diagrammatic representation students were able to appreciate it *(e, P)* … So today's teaching was successful in my opinion *(e, P)*. Most of the students were happy *(e, P)*. And one of the students said that: If we can do this every now and then, then it is going to make learning easier and more appreciable *(e, P)*.

Steve reflected on the increase in students' motivation, which propelled his confidence in the knowledge he had attained *(c)*. He also reflected on the change in his knowledge and skills regarding the course content *(d; b, P)* and its presentation *(e, P; d)*. Concerning collaboration in the team, Steve said:

> Teamwork for a moment changed my state of isolation in my area to working hand in hand with others *(3, P*)*. For me, it was not only an eye opener *(b, P*)* but was also refreshing *(e, P*)* because even though there were some things I knew, in the team, I got to know much about them in a greater dimension *(b, P*; c)*, for instance ... I was more inclined towards developing teaching material but I learnt in the team about also developing equipment concepts due to practical skill competencies *(3, P*; 2, P*)*.

Steve got to improve his knowledge among colleagues in the team *(b, P*)* as he drew ideas from them *(b, P*)* and further contributed to improving teaching of the course *(3, P)*.

Harry

Harry found it important to continually improve professionally, and added:

> ... as the world constantly changes, so I want to expose my students to current things so that when they get to the industry, they know what they are about *(a)*.

Reminiscing about his industry site encounter, Harry stated that:

> Although I know that GRIDCO uses SF6 circuit breakers, I had not seen one until we went there. I saw how the change-over switches and focus relays work, how to test oil and cool the transformers *(a)*. The transformers I knew had separate cooling systems but with the modern ones I saw, they are incorporated *(a)*. I knew tap changing the analogue way but I now discovered the new digitally operated transformers which save time and energy *(a)*.

He was also quick to admit that:

> There is now a lot of software development which our students need to know and I am going to teach them these *(3, P; 2, P)*.

The course design facets were learning grounds for Harry, as he pointed out in the following quote:

> Actually incorporating some new things in our pretty old syllabus builds a lot of confidence in me *(b, P*)*. I discovered in the syllabus that though the principles with the old systems are the same, the operations change *(b, P*)*.

Harry taught his class on *Tap Changing* and indicated:

> It is very revealing, because with tap changing, we have always been teaching about the analogue type but this was an opportunity for me to introduce the digital system types to my students *(3, P; 2, P)*. It was a livelier class than usual *(e, P)* to see students making useful contributions in class *(e, P)*. They worked in groups on the transformers and it became student-centred unlike before *(e, P)*.

According to Harry, teamwork offered *abundant learning opportunities (e, P*; b, P*)*. He explained his assertion as follows:

> I learnt to share my ideas with fellow teachers *(b, P*; e, P*)* and collaborate with others to build a strong knowledge-base for my course *(b, P*)* ... most of all I learnt to be creative

> *(b, P*; e, P*)*, became humble *(e, P*)* and was open to change *(e, P*; c)* ... I thought I was an expert in handling the course until it came to me as a big surprise that others have wonderful ideas to offer to improve it *(d; 4, P)*.

About collaboration in the team, Harry said:

> Individuals are doing their respective researches here and there, but collaboration in the team unearthed other teachers' research work *(e, P*; c)* ... It was interesting ... to tap information from each other *(e, P*; c)*.

Production Engineering Team

Ernest

Change was the uppermost agenda for Ernest. His target was to bring something new into his course and into the classroom *(1)*. Thus, he stated about the industry site visit that:

> We learnt ... generally about foundry works and methods of joining metals which enhanced my knowledge *(a)*. I learnt about how castings are repaired when they don't come out well *(a)*.

The following are Ernest's observations during course design:

> I found out how to come up with specific topics and aspects of the syllabus that we wanted to hammer on since they are core parts of the HND course *(3, P*)*. I had the idea not to teach students something which is antiquated *(b, P*)*. I learnt to impart occupationally oriented contents of skilled work ... subjects, tools, methods, technology *(b, P*)*. Most of all delving into the syllabus was a new learning experience for me *(b, P*)*.

During the teaching tryout, Ernest took his students through *Joinery Methods* and remarked:

> Apart from an updated content *(a; b, P*)*, the delivery method was different *(e, P; c)* because I now had a lot of pictures from industry to support what I was saying *(2, P)*; a lot of pictures and videos spoke for themselves *(2)*. The students showed a lot of interest and asked more relevant questions than previously *(e, P; 3, P*)*. Indeed, my industry experience kept me at ease in our class discussion on the topic *(b, P)*.

Ernest shared his thoughts about his lessons in the team, saying:

> Teamwork paved the way for me to know from colleagues, things I never knew *(b, P*; e, P*)*. I found out how to tolerate individual differences in the team *(4, P*)* and I learnt to be circumspect in communicating information to be discussed *(4, P*)*. We collaborated to share ideas *(3, P*)* and worked hand in hand to achieve set targets *(3, P*)* ... that unity of purpose was there *(e, P*)*.

Leonard

Leonard was interested in acquiring relevant knowledge from industry to update his knowledge and his course, and looked forward to getting some hands-on training *(1)*. He indicated the following about the industry site visit:

> I encountered machines which earlier on I had never had the opportunity to operate myself like the radial drilling machine and vertical boring machine *(a)* ... I liked the experience *(a)*. My confidence was reinvigorated *(a)*. My students are going to benefit from this *(2, P; 3 P)*.

The course design process also offered Leonard some learning experiences, which he described as follows:

> At the onset, I got to know how to identify need areas in the syllabus *(b, P*)*. I also expanded my knowledge on competencies for my course *(a; b, P*)*. I now know competency standards are made up of units of competency *(a; b, P*)*, which are themselves made up of elements of competency *(a; b, P*)*.

Leonard taught *Hydraulics* during the teaching tryout and indicated that:

> I realized that most of the students appreciated the format *(e, P)* ... the pictorial representation *(e, P)* and the PowerPoint presentation on the maintenance of hydraulic systems in heavy duty off-road trucks *(e, P)*. One student said: ...Sir, things are a lot of clearer today *(e, P)*.

In his remarks on teamwork, Leonard said:

> Teamwork can never be downplayed since knowledge gained from my follow teachers was valuable *(b, P*; e, P*)* … In the team I acquired the idea of developing occupationally oriented tasks for students and confronting them with occupational problems *(3, P*; 3, P)*. I tapped into the experience of others *(b, P*)* and developed in creativity *(b, P*; e, P*)*. I also got to know that colleagues are always ready to help when you consult them *(b, P*)* and that it's not helpful to work in isolation ... especially in academia *(e, P*)*. We all got involved and were ready to share ideas *(c, 4; P*S)*.

Teacher Professional Growth as Depicted by the Enactment and Reflection Processes

Domain of Practice and Personal Domain

Tracing teacher professional growth revealed that individual teacher learning occurred most significantly between the *domain of practice* and the *personal domain*. Teacher participation in curriculum design activities increased knowledge of curriculum design and content. Analysing the course structure, incorporating competencies that students need to possess, balancing technical and industry-specific skills, and bridging the gap between the syllabus and industry competency standards were among the concrete practical tasks and learning experiences in enactment that brought teachers face to face with their subject matter. Additionally, teachers' reflections on subject matter, delivery and outcomes in the teams enhanced interaction and knowledge sharing. Their participation in design teams was enactment-driven and improved their collaboration, making them discover how to share knowledge and ideas, communicate with others, be creative, broadminded and tolerant, as well as making them learn how to find information on their subject matter.

Teachers' presentation of subject matter was enhanced when they conducted teaching tryouts of the updated courses, an upshot of enactment. The success of classroom implementation also depended on the up-to-date knowledge teachers got from industry site visits and the skill to present subject matter to students, both of which were revealed in the enactment process and were shown to increase teacher confidence in the content.

External Domain and Personal Domain

Teacher learning was notably present between the *external domain* and the *personal domain*, as all the teachers became involved in the industrial site visit to learn about current industrial operations in place. In effect, the opportunities teachers had to reflect individually and as a team on the input provided by the industrial site visit augmented their knowledge and beliefs about their subjects. Apart from getting to know about relevant industrial trends, teachers individually handled equipment in brief training sessions to improve their hands-on experience. This was the case for all teachers except for Melvin and Julian. They visited hydro-electric generating stations and thermal plants where power is constantly flowing and could not be shut down at the time of their visit for them to use the equipment. The introductory workshop on collaborative curriculum design was a forum where teachers obtained more knowledge on course design in teacher design teams. Further, the interaction between teachers and the facilitator of the introductory workshop about course design also shows how reflection contributed to teachers' growth.

External Domain and Domain of Practice

All of the teachers except Julian expressed their experience of knowledge acquisition between the *external domain* and the *domain of practice*. The teaching try-outs were based on the updated courses and were also a learning ground for teachers, enabling them to practice what they had learned from the industry site visits. In this light, certain equipment and practical operations from industry were taught to students based on the teachers' field experiences. There were software developments and automated/digital systems which teachers encountered in industry and introduced in the classroom. A derivative of enactment was revealed during collaborative curriculum design, as teachers learnt to bridge the gap between the syllabus and industry competency standards, and design situational learning experiences based on their understanding of workplace contexts and changes. Their design tasks called for documenting the newly acquired knowledge from industry to restructure their syllabi in ways that reflected the current needs of industries.

Domain of Practice and Domain of Consequence

Appreciable amounts of teacher growth took place between the *domain of practice* and the *domain of consequence*. The students showed a lot of interest in the topics, classes became livelier as they encouraged students' discussion. Clarity and presentation of topics were rated high as the presentation was supported with pictures from industry. When reflecting on the try-out, teachers used words such as "refreshing", "revealing" and "an eye opener".

There were consequences of working in design teams that emanated from the reflection process, such as tolerance of diverse characters and behaviours, seeking ideas from colleagues, unearthing of research ideas, learning to communicate with others, uniting with others to achieve set targets, humility, creativity, and being open to change.

Collaborative curriculum design brought to light salient teacher outcomes reflected in the implementation of their redesigned courses, such as discovering competencies, including industry skills in the syllabus, ensuring hands-on technical skills, being able to analyse the course structure, knowing certain competencies that students need to possess, being able to bridge the gap between the syllabus and industry competency standards and imparting occupationally oriented content about skilled work, among others.

Domain of Consequence and Personal Domain

Apart from Melvin and Julian, all of the other teachers displayed professional growth between the *domain of consequence* and the *personal domain.* This was primarily revealed through the reflection process. The teaching try-out propelled teachers' confidence in both the delivery method and the knowledge they had attained, and intensified their practical knowhow. Their knowledge and skills changed after modifying the course content and presenting it. Teacher collaboration gave them ideas that expanded their knowledge and contributed to updating their courses.

Discussion

This chapter reports the results of a study aimed at identifying teachers' learning processes in design teams that contribute to their professional growth. Data from interviews and field notes were collected over the 14-week journey of updating courses and subsequent classroom tryout for six teachers in three different design teams. Next, we discuss in detail teacher learning as diagnosed by the enactment and reflection processes of the IMPG.

Teachers grew professionally during the cycle of collaborative curriculum design and the use of the redesigned curriculum in class teaching as diagnosed in all four domains of the IMPG (Clarke & Hollingsworth, 2002). In particular, their knowledge, attitudes and skills developed in the interaction with colleagues and industry during collaborative curriculum design and, ultimately, culminated in re-designed curriculum materials. The focus of the teacher design teams was on curriculum development and teaching; however, as an offshoot the process served as a learning experience for the individual teachers themselves, as was uncovered through analysis of the enactment and reflection processes. Implementation of the re-designed curriculum materials in the classroom was a crucial factor that contributed to professional growth, while reflection was mainly a pondering and intermediary factor, which helped to reinforce knowledge.

The IMPG unearthed details of teacher professional growth emanating from the teachers' own professional practices and the interdependence of multiple factors in diagnosing teacher change. Teacher professional growth had a situative (in the domain of practice and the domain of consequences; Greeno, 2003; Putnam & Borko, 2000) and cognitive (in the personal domain; Greeno et al., 1996) nature. The beliefs, knowledge and skills that were developed were situated in their practices in the classroom and in the collaborative curriculum design. Teamwork in teacher design teams enhanced individual professional growth, confirming that professional development can be pervasive when learning is viewed as a collective enterprise, as in professional communities (cf. Gallagher & Ford, 2002). Through a team approach, teachers continually utilized the instructional resources and skills of their peers to support mutual growth and attainment of shared instructional and curricular goals (Glazer & Hannafin, 2006). Therefore, this study contributes to characterizing the learning and development processes teachers are engaged in when actively involved in collaborative curriculum design. Further, the results pertaining to the growth outcomes in the four domains contribute to the discussion of the integrity of the knowledge acquired by these teachers, whether it has a situative or a cognitive nature, as stipulated by Greeno and Van de Sande (2007) and discussed by Alexander (2007) and Alexander et al. (2009).

Limitations

One might argue that the IMPG model (Clarke & Hollingsworth, 2002) and the approach to teacher professional development used in this study do not necessarily fit in the cultural context of Ghana's polytechnics. Gervedink Nijhuis, Pieters, and Voogt (2013) studied cultural differences between Ghana and the Netherlands in a collaborative project aiming to contribute to the professional development of the polytechnics' heads of department. They concluded that curriculum design activities were affected by the cultural factors introduced by Hofstede (1980) and typified as Collectivism, Context, and Time. In our study, the influence of culture on stakeholders' values, and on the educational context in which the curriculum design activities were conducted and the curriculum would be implemented, became more obvious during the curriculum development process. The cultural factors identified by Gervedink Nijhuis et al. (2013) positively affected the introduction of collaborative curriculum design and the subsequent teacher learning. Based on their findings, Gervedink Nijhuis et al. (2013) advocated conducting an in-depth context analysis to serve as input for professional development and careful monitoring of the outcomes and impact of the professional development arrangement for the teachers and their practices. In the present study, the approach to professional development was based on a context analysis (Bakah et al., 2012a) and the sustainability of the intervention was investigated in a follow-up study (Bakah, Voogt, & Pieters, 2012c). The context analysis made explicit which cultural issues had to be taken into account in the design of the professional development arrangement and the analysis of the findings. The follow-up study resulted in clear (partly cultural) conditions for the sustainability of the approach for teacher learning and its impact on practice.

Another limitation of this study concerns the analysis of only self-reported data. All the references to professional growth are based on teachers' perception and awareness of their learning. That notwithstanding, professional development in the design process can be inferred from this study, and the IMPG helped to assess teachers' perceptions. Finally, another potential limitation concerns the narrow focus of the design activities by teachers, which was due to the limited period of 14 weeks for the design activities. However, the teachers were convinced that the design activities they carried out were a major step in the series of curriculum design activities ongoing in the polytechnics. The groups worked on their own during the design process, which is a gratifying sign for effective future attempts by teachers to update their courses.

Conclusion

Tracing teacher growth through the IPMG revealed how the teachers developed in their thinking during design conversations about curriculum design and subject matter update in teams. The analysis shows that the patterns of the participating teachers' growth have more similarities than differences, both between individual teachers and across the three design teams studied. This was observed in the ensuing discussion of the enactment and reflection processes. The groups evolved with time, both in terms of collaboration and cohesion. The individuals took advantage of teamwork to maximise their learning potential and let it impact their teaching. Thus, in this study, teachers changed with respect to their knowledge of their respective subject areas and their use of teamwork in curriculum design.

The findings in this study also have implications for teacher professional development in polytechnics and other educational institutions in Ghana, as well as in other developing countries. By employing the IMPG for an analytical look into the components of design activities by teachers, empirical grounding has been offered for the intertwined changes in individual teacher knowledge and the sensitivity of these changes to the complex interactions with content and teaching. Similarly, polytechnics in developing countries may need to consider assessing teacher change in terms of professional growth to discover teachers' idiosyncratic and personal development in all avenues of their profession, thereby acknowledging the situated and personal nature of teacher practice.

References

Alexander, P. A. (2007). Bridging cognition and socioculturalism within conceptual change research: Unnecessary foray or unachievable feat? *Educational Psychologist, 42*, 67–73.

Alexander, P. A., Schallert, D. L., & Reynolds, R. E. (2009). What is learning anyway? A topographical perspective considered. *Educational Psychologist, 44*, 176–192.

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012a). Professional development needs of polytechnic lecturers in a curriculum reform scenario. *International Journal of Training and Development, 16*(1), 67–76. https://doi.org/10.1111/j.1468-2419.2011.00389.x

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012b). Updating polytechnic teachers' knowledge and skills through teacher design teams in Ghana. *Professional Development in Education, 38*(1), 7–24.

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012c). Advancing perspectives of sustainability and large-scale implementation of design teams in Ghana's polytechnics: Issues and opportunities. *International Journal of Educational Development, 32*(6), 787–796.

Billett, S. (2009). Personal epistemologies, work and learning. *Educational Research Review, 4*, 210–219.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32–41.

Burrell, A. R., Cavanagh, M., Young, S., & Carter, H. (2015). Team-based curriculum design as an agent of change. *Teaching in Higher Education, 20*(8), 753–766. https://doi.org/10.1080/13562517.2015.1085856

Clandinin, J., & Connelly, F. (1992). Teacher as curriculum maker. In P. Jackson (Ed.), *Handbook of research on curriculum* (pp. 363–401). New York: Macmillan.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*, 947–967.

Coenders, F., Terlouw, C., Dijkstra, S., & Pieters, J. (2010). The effects of the design and development of a chemistry curriculum reform on teachers' professional growth: A case study. *Journal of Science Teacher Education, 21*(5), 535–557.

Deketelaere, A., & Kelchtermans, G. (1996). Collaborative curriculum development: An encounter of different professional knowledge systems. *Teachers and Teaching: Theory and Practice, 2*(1), 71–85.

Desimone, L. M. (2011). A primer on effective professional development [Editorial material]. *Phi Delta Kappan, 92*(6), 68–71.

Eraut, M. (2007). Learning from other people in the workplace. *Oxford Review of Education, 33*(4), 403–422.

Gallagher, K. L., & Ford, K. J. (2002). 90 minutes a day aims to create a new culture. *Journal of Staff Development, 23*(4), 65–68.

Gervedink Nijhuis, C., Bakah, M. A. B., & Akomaning, E. (2009). Leadership challenges involved in managing institutional and curriculum changes in polytechnics. In W. Kouwenhoven, G. Oduro, & K. Nsiah-Gyabaah (Eds.), *Trends in polytechnic education in Ghana* (pp. 85–100). Amsterdam: Vrije Universiteit.

Gervedink Nijhuis, C. J., Pieters, J. M., & Voogt, J. M. (2013). Influence of culture on curriculum development in Ghana: An undervalued factor? *Journal of Curriculum Studies, 45*(2), 225–250.

Glazer, E. M., & Hannafin, M. J. (2006). The collaborative apprenticeship model: Situated professional development within school settings. *Teaching and Teacher Education, 22*, 179–193.

Greeno, J. G. (2003). Situative research relevant to standards for school mathematics. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 304–332). Reston, VA: National Council of Teachers of Mathematics.

Greeno, J. G., Collins, A. M., & Resnick, L. B. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–46). New York: Macmillan.

Greeno, J. G., & van de Sande, C. (2007). Perspectival understanding of conceptions and conceptual growth in interaction. *Educational Psychologist, 42*, 9–23.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record, 103*(6), 942–1012.

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams*. (Doctoral thesis). Enschede, The Netherlands: University of Twente.

Hoekstra, A., Beijaard, D., Brekelmans, M., & Korthagen, F. (2007). Experienced teachers' informal learning from classroom teaching. *Teachers and Teaching, Theory and Practice, 13*(2), 189–206.

Hofstede, G. H. (1980). *Culture's consequences: International differences in work-related values*. Beverly Hills, CA: Sage.

Hord, S. (2004). *Learning together, leading together. Changing schools through professional learning communities*. New York: Teachers College Press.

Little, J. W. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record, 105*(6), 913–945.

Loveder, P. (2005). *World trends in staff development: Implications on the performance of technical education institutions*. Paper presented to the National Seminar on the Development of Technology and Technical–Vocational Education and Training in an Era of Globalization.

Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed.). London: Sage Publications.

Millar, R., Leach, J., Osborne, J., & Ratcliffe, M. (2006). *Improving subject teaching: Lessons from research in science education*. London: Routledge Falmer.

Neuendorf, K. A. (2002). *The content analysis guidebook*. Thousand Oaks, CA: Sage.

Nieveen, N., Handelzalts, A., Van den Akker, J. J. H., Homminga, S. (2005). *Teacher design teams: A scenario for school–based curriculum innovation.* Paper presented at the European Conference on Educational Research.

Nsiah-Gyabaah, K. (2005). *Polytechnic education in Ghana: The past, the present and the future.* Paper presented at the Kick-off Conference: NPT/ UCC Project on Building Management and Leadership Capacity in Polytechnics, Cape Coast, Ghana.

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Penuel, W. R., Riel, M., Krause, A. E., & Frank, K. A. (2009). Analyzing teachers' professional interactions in a school as social capital: A social network approach. *Teachers College Record, 111*(1), 124–163.

Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics, 56*, 67–96.

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15.

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher, 16*(9), 13–20.

Schön, D. A. (1987). *Educating the reflective practitioner: Towards a new design for teaching and learning in the professions*. San Francisco: Jossey-Bass.

Simmie, G. M. (2007). Teacher design teams (TDTs) – building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies, 26*(2), 163–176.

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review, 3*, 130–154.

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*, 1235–1244.

Wenger, E. (2003). *Communities of practice: Learning, meaning, and identity* (2nd ed.). Cambridge, UK: Cambridge University Press.

Yin, R. K. (2003). *Case study research design and methods* (3rd ed.). London: SAGE Publications.

Chapter 17
From Needs Analysis to Large-Scale Implementation: Using Collaborative Design to Support ICT Integration

Douglas D. Agyei

Introduction

The importance of mathematics in the development of a country should not be underestimated, as it plays a major role in the economy and the social life of its people. Due to its importance, the government of Ghana is committed to ensuring that high quality mathematics education is provided. In spite of government efforts, however, mathematics education has not undergone much change in terms of how it is structured and presented, resulting in consistently low achievement levels among mathematics students in high schools (e.g., see Mullis, Martin, & Foy, 2008; Ottevanger, Van den Akker, & de Feiter, 2007). The method of teaching mathematics is considered one prominent factor among the reasons for this low achievement. Ottevanger et al. (2007) indicated that the most frequently used strategy in mathematics classrooms is the teacher-centred (chalk and talk) approach in which teachers do most of the talking and intellectual work, while students are passive receptacles for the information provided. According to Ottevanger et al. (2007), this type of teaching is heavily dominated by teachers (while students are silent), involves whole class teaching, lots of notes being copied, and hardly any hands-on activities. In most instances, teachers rush to cover all the topics mechanically in order to finish on time for examinations, rather than striving for in-depth student learning (Ottevanger et al., 2007). Such teacher-centred instructional methods have been criticised for failing to prepare students to attain high achievement levels in mathematics (Hartsell, Herron, Fang, & Rathod, 2009). In the recent past, policy makers and mathematics educators have paid increased attention to how to teach mathematics in a way that can be understood and appreciated by students. Numerous researchers have reiterated the potential impact of ICT use on the

D. D. Agyei (✉)
Department of Mathematics and ICT Education, University of Cape Coast,
Cape Coast, Ghana
e-mail: ddagyei@ucc.edu.gh

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_17

development and expansion of new and existing mathematical concepts and on students' achievement (Beauchamp & Parkinson, 2008; Bottino & Robotti, 2007; So & Kim, 2009). Guerrero (2010) indicated that mathematics is one area that has seen dramatic growth in the influence and applications of ICT on the development of content and the evolution of instruction. Similarly, the Association of Mathematics Teacher Educators (2006) stated that "ICT has become an essential tool for doing mathematics in today's world, and thus … it is essential for the teaching and learning of mathematics" (p. 1). The government of Ghana shares this view, and considers ICT literacy as an engine for accelerated development, as outlined in the Ghana Information and Communication Technology for Accelerated Development (Ghana ICT4AD Policy, 2003). Ghana introduced ICT into the school curriculum in September, 2007, following the recommendations of the ICT4AD document and the Anamuah-Mensah National Education Review Committee Report (2002). Both documents highlighted the importance of integrating ICT into the curriculum at all levels. Computer literacy has been introduced not only as a new subject in the curriculum, but also as a tool to enhance teaching and learning. The new curriculum in mathematics at the senior high school level encourages teachers to make use of the calculator and the computer for problem solving and investigations of real life situations, in order to help students acquire the habit of analytical thinking and the capacity to apply knowledge in solving practical problems (Ministry of Education (MOE), 2000; Ministry of Education, Science and Sports (MOESS), 2007). As a result, the government and other institutions have invested huge sums of money in procurement of computers and establishment of computer labs in most Senior High Schools (SHS), but it is still unclear whether these computers are being used effectively by teachers in their instruction.

This new orientation to mathematics teaching and learning supported by ICT requires more than recommendations contained in syllabi. Policy makers and training institutions should advocate for radical changes in approaches to teaching. Teachers should adopt new roles and be prepared to be innovative and creative in the integration of ICT in their classroom, thus presenting concepts and theories easily to students and providing them with better education. This chapter presents findings from multiple studies conducted to support teachers in this transition. Specifically, the studies reported here focused on how to enhance professional development arrangements by providing pre-service teachers with opportunities and support to collaboratively design and use ICT–enhanced teaching materials for mathematics instruction.

The Research Context

Teacher Preparation Programmes for Teaching Mathematics in Ghana

The Senior High School (SHS) mathematics curriculum in Ghana focuses on attaining one crucial goal: to enable all Ghanaian young persons to acquire the mathematical skills, insights, attitudes and values that they will need to be successful in their chosen careers and daily lives (MOESS, 2007). This curriculum is based on the premises that all students can learn mathematics and that all need to learn mathematics. At the SHS level, the student is expected to develop the required mathematical competencies to be able to use his/her knowledge in solving real life problems, and to be well equipped to enter further study and associated vocations in mathematics, science, commerce, industry and a variety of other professions (MOESS, 2007). The rationale of the curriculum has therefore many implications for teaching strategies and the training of mathematics teachers for SHS.

In Ghana, mathematics teacher education for SHS was until recently offered by two main institutions, the University of Cape Coast (UCC) and the University of Education, Winneba (UEW). These two universities are institutions for higher education that have the specific task to train teachers for SHS. The main route in teacher education at both UCC and UEW is the Bachelor of Education qualification programme which is run for a period of 4 years. Three main components are present in the programmes offered by both universities: content courses, education courses and student internship. The content courses are designed to equip students with sufficient content knowledge for their future teaching subjects. The education courses are further sub-divided into general and subject-specific courses. The latter are taught in the subject-specific education departments and denoted as pedagogy courses (for example, the Department Mathematics and ICT Education is responsible for teaching mathematics-related pedagogy courses). The general education courses are taught in other education departments, particularly Educational Foundations and Psychology. Similarly, a separate department referred to as the Teaching Practice Unit is responsible for the administration and organisation of students' placement in schools during their internship.

The studies reported here were conducted within the context of the teacher education programme at UCC.

Mathematics Teacher Preparation Programme and ICT Integration at UCC

UCC is one of the rare sea-front universities in the world. It was established in October, 1962, as a University College, and placed in a special relationship with the University of Ghana, Legon. The University was established based on a dire need for highly qualified and skilled manpower in education to provide leadership and enlightenment. Its original mandate was therefore to train graduate professional teachers for Ghana's second cycle institutions (elsewhere called secondary education) and the Ministry of Education, in order to meet the manpower needs of the country's accelerated education programme at the time. The College of Education Studies (formally known as the Faculty of Education) is one of the largest colleges in terms of student numbers at the University of Cape Coast. It admits close to 40% of the total student population in the regular stream. The College has four faculties each consisting of a number of departments, centres and/or institutes. Among the departments is the Department of Mathematics and ICT Education which trains mathematics teachers mainly for second cycle institutions in the country.

A review of the courses offered within the 4-year mathematics teacher education programme revealed two issues that were of major importance to this research: the status of ICT integration in teacher preparation and the different teaching methods adopted by instructors in the programme. The only ICT course (computing) offered to the students is during the first semester of the 1st year (taught as a subsidiary and optional subject by the computer science department of the university). In this course, students learn basic computing skills such as familiarity with the operating system, word processing, spreadsheets, and presentation software. Besides the computer literacy course, the mathematics teacher preparation programme also offers a course in Educational Technology, a two-credit hour course in the second semester of year 1. This course is mainly theoretical, merely exposing students to various educational technologies. This means the programme does not give prospective teachers the chance to learn about technology and how to incorporate it into their own teaching. Consequently, pre-service teachers' experience with integrating technology in teaching is limited, making the programme fall short of a practical approach. This leads to the big question as to whether the trained pre-service teachers are sufficiently prepared for new teaching methods that are flexible and involve appropriate use of technology.

Alongside concerns regarding the content of the programme with respect to ICT, instructors at the mathematics teacher preparation programme have limited use, or in most cases, no use of ICT in their teaching practice. Most instructors at this programme use a teacher-centred approach or lecture-based instruction by which the teachers are doing most of the talking and intellectual work, while students are passive receptacles for the information provided. These instructors do not integrate ICT in their instruction due to a lack of technology integration skills (especially for older staff members). At best, some instructors are knowledgeable about ICT applications, but do not have the skills to effectively integrate them in their courses. This is likely to have a ripple effect on the professional practice of these prospective teachers. One possible reason for limited implementation of new technologies by instructors is the dependence on the traditional view of teaching and learning. As Becker (2001) concluded, teachers who believe in a more traditional transmission-oriented approach will find most computer applications incompatible with their instructional goals, and will therefore use a limited range of computer technology in their instruction. Given the observations related to the integration of technology in education and the current emphasis on teacher-centred education at the mathematics teacher preparation programme, it is proper to explore possible ways to incorporate new teaching styles for active learning that use more supportive ICT resources in the mathematics teacher education programme.

Teacher Preparation for ICT Integration

Effective Technology Integration Through Introduction of Technological Pedagogical Content Knowledge (TPACK)

Meaningful use of ICT in education requires teachers to develop the knowledge and skills that enable them to integrate ICT with a suitable pedagogical approach for teaching specific subject matter in a certain context. Keating and Evans (2001) found that pre-service teachers felt comfortable with ICT in their schoolwork and daily practices, but felt unconfident about using ICT in their future classrooms. One possible reason was the comprehensive set of knowledge and skills that these pre-service teachers lacked. Koehler and Mishra (2008) introduced Technological Pedagogical Content Knowledge (TPACK) as a conceptual framework to describe the knowledge base teachers need for effective teaching with ICT. TPACK builds on Shulman's (1986) concept of pedagogical content knowledge, which highlights the importance of the complex interrelationships among teachers' knowledge about content and pedagogy, and the need for teachers to learn about various ways of representing subject matter. Mishra and Koehler outlined the TPACK framework (Koehler & Mishra, 2008; Mishra & Koehler, 2006) in an effort to explain the types of knowledge teachers need in order to integrate ICT into their teaching (see Fig. 17.1).

They argue that effective ICT integration for teaching specific content or subject matter requires understanding of the relationships between three primary forms of knowledge that a teacher needs: Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK), as well as the interplay and intersections between them (Pedagogical Content Knowledge, PCK; Technological Content Knowledge, TCK; Technological Pedagogical Knowledge, TPK; and Technological Pedagogical Content Knowledge, TPACK). PCK is knowledge about teaching specific content, as explained by Shulman (1987). TPK is an understanding of how teaching and learning change when a particular ICT application is used. TCK is an understanding of the manner in which ICT and content influence and constrain each other. TPACK is the intersection of all three knowledge areas (TK, CK and PK). Understanding of TPACK is above and beyond the understanding of TK, CK, and PK in isolation. In the current research project, TPACK was used as a conceptual framework to examine the knowledge and skills pre-service math teachers developed about ICT, pedagogy and content. Specifically, the current research project investigated the development of pre-service teachers' TPACK as they used spreadsheets as a tool for enacting a guided activity-based pedagogical approach to

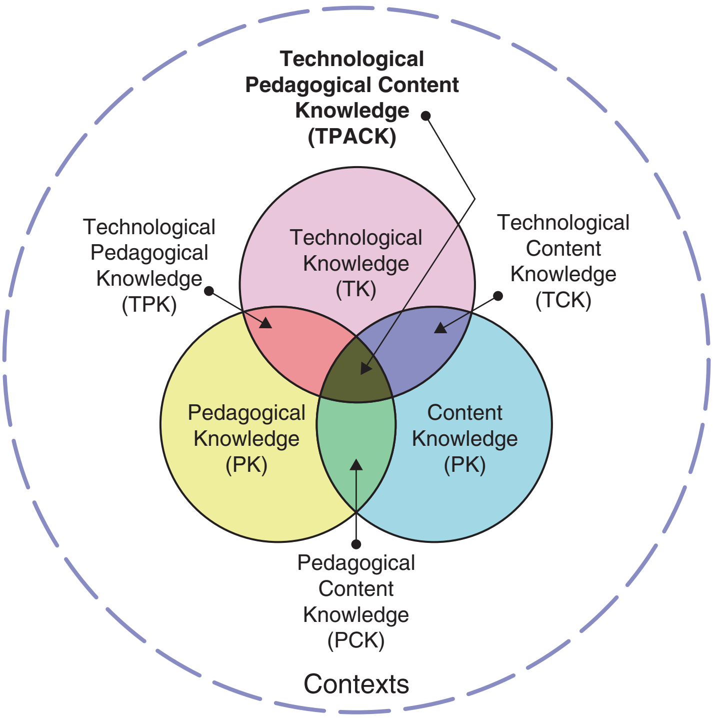


Fig. 17.1 TPACK framework. (Koehler & Mishra, 2008)

teaching mathematics concepts. In the next sections, the theoretical underpinnings of the professional development arrangement are described.

Potential of Spreadsheet for Mathematics Education

Agyei and Voogt (2011a, 2011b) reported that although the government of Ghana has put into place support systems in schools to facilitate access to computers, a lack of ICT infrastructure continues to be an issue in most mathematics classrooms. The study indicated that schools lacked common mathematical software (e.g., Graphic Calculus, Geometer's Sketchpad) typically used in teaching mathematics. Bearing in mind the complexity of the problems most mathematics classrooms in Ghana face in terms of ICT infrastructure and lack of software, spreadsheets were used to enhance a professional development arrangement to develop pre-service technology integration competencies. This is a technology that is readily available in mathematics classrooms and is user-friendly. According to Niess, Sadri, and Lee (2007), teachers who are able to design and enact spreadsheet lessons experience elementary concepts of mathematical modelling, expand their own conceptions of teaching mathematics with spreadsheets, investigate and expand their knowledge of instructional strategies for integrating spreadsheet learning activities, develop their own knowledge and skills about spreadsheets as tools for exploring and learning mathematics, and explore curricular materials that support learning with and about spreadsheets over an extended period of time. The choice to use spreadsheets in the training programme was appropriate also in the sense that teachers would be able to use existing hardware and software in creative and situation-specific ways to design ICT resources to accomplish their teaching goals in the future.

Activity-Based Learning (ABL) Pedagogical Approach

The idea of ABL is rooted in the common notion that students are active learners rather than passive recipients of information, and that learning, especially meaningful learning, involves activity (Churchill & Wong, 2002). ABL describes a range of pedagogical approaches to teaching mathematics. Its core premises include the requirement that learning should be based on doing hands-on experiments and activities. Churchill (2004) argued that an active interaction with a learning object enables construction of learners' knowledge. Accordingly, he stated that the goal of ABL is for learners to construct mental models that allow for 'higher-order' performance such as applied problem solving and transfer of information and skills. This suggests that in ABL approaches, learners are actively involved, the environment is dynamic, the activities are interactive and student-centred, and much emphasis is placed on collaboration and exchange of ideas. The ABL approach was used in this study to ensure that teaching and learning were based on hands-on activities.

Learning ICT by Collaborative Design and Pre-service Teachers' Design Teams

Research has shown that needs-based collaborative professional development is effective in developing the competencies teachers need to adequately integrate ICT in their classroom practice (Haughey, 2002; MacDonald, 2008). Koehler and Mishra (2005) recommended that developing TPACK should be done through "Learning Technology by Design", an approach in which teachers are involved in collaborative and authentic problem-solving tasks with ICT. Specifically, by actively participating in the design process, teachers build competencies that are sensitive to the subject matter (instead of learning about the ICT in general) and to specific instructional goals (instead of general ones) relevant for addressing the subject matter. The Learning Technology by Design approach adopted in this study seeks to put pre-service teachers in roles as designers of ICT-enhanced environment as they work collaboratively in small groups to develop ICT-based solutions to authentic pedagogical problems. Angeli and Valanides (2005) argued that such a design-based learning approach contributes to preparing future teachers to be competent to teach with ICT in ways that signify the added value of ICT. Polly, Mims, Shepherd, and Inan (2010) indicated that among other benefits, the flexibility in such collaborations allows pre-service teachers to familiarise themselves with each other and the idea of ICT integration, and contributes to the success of curriculum design teams.

Research Questions

The teacher factor is considered one of the prominent reasons for students' poor achievement in mathematics in Ghana. The instructional approach is mainly teacher-centred, which is characterised by transmittal techniques (chalk and talk, dominated by teacher talk), making students completely dependent on teachers. Recent research findings from mathematics education show that integration of ICT can change the nature of teaching and learning (Agyei & Voogt, 2011a). However, integrating ICT in teaching mathematics is a very complex and difficult task for mathematics teachers in Ghana. They have to learn to use new technologies appropriately and to incorporate ICT in lesson plans and lesson enactment. Professional development is therefore critical towards helping pre-service teachers to develop the proper skill set and required knowledge before such instructional change can occur. The current research focuses on enhancing professional development arrangements in which pre-service teachers collaboratively design and use ICT–supported teaching materials. Based on this purpose, the main research question was formulated as:

> How should "collaborative design" in design teams be applied in pre-service teacher education to prepare pre-service mathematics teachers for the integration of ICT in their future lessons?

The research approach applied in this study to seek an answer to the main research question was design-based research. The four main phases of the research were the needs and context analysis, design and implementation, large-scale implementation and a transfer study. The following sub-research questions guided the research phases:

Study 1: Needs and context analysis:

- RQ1: How do prospective and practicing mathematics teachers differ in their attitudes towards ICT integration (will), competencies for ICT integration (skill), access to ICT (tool) and their levels of technology integration?
- RQ2: To what extent do attitudes towards ICT integration (will), competencies for ICT integration (skill) and access to ICT (tool) predict mathematics teachers' technology integration levels?
- RQ3: What are the barriers to ICT use in teaching mathematics in SHS in Ghana?
- RQ4: What are the needs of pre-service and in-service mathematics teachers in teaching mathematics with ICT in SHS in Ghana?

- RQ5: What are the opportunities for ICT use in the teaching of mathematics in SHS in Ghana?

Study 2: Design and implementation:

- RQ6: What are pre-service mathematics teachers' experiences in developing and implementing technology-enhanced lessons through collaborative design teams?
- RQ7: To what extent do pre-service teachers develop knowledge and skill in designing and enacting spreadsheet-supported ABL lessons, and how does this impact secondary school students' learning outcomes?

Study 3: Large-scale implementation

- RQ8: How do the implementation strategies applied in the IT course affect pre-service mathematics teachers' technology competencies (knowledge, skill, and attitudes,)?
- RQ9: What is the impact of the mathematics–specific IT course on pre-service teachers' technology integration competencies (knowledge, skills, and attitudes)?

Study 4: Transfer of learning

- RQ10: What is the potential for implementing instructional technological innovations in teaching senior high school mathematics?

Methodology

Design-Based Research

The main methodology in the studies reported in this chapter was design-based research. Wang and Hannafin (2005) defined design-based research as a systematic but flexible methodology aiming to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings. According to Barab and Squire (2004), design-based research is a series of approaches with the intent of producing artefacts and practices to contribute to a design theory that accounts for and potentially impacts learning and teaching in naturalistic settings. Van den Akker, Gravemeijer, McKenney, and Nieveen (2006) in their extensive work on design-based research have indicated that the compelling argument for initiating design-based research stems from the desire to increase the relevance of research for educational policy and practice, to develop empirically grounded theories through combined study of both the process of learning and the means that support that process, and finally, but not least, to increase the robustness of design practice. There is little debate that, in any domain, the design-based research process tends to be iterative (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). Analysis is conducted in order to understand how to target a design, and evaluation is both formative (i.e., performed to improve the quality of prototypes) and/or summative (i.e., to determine the impact of the intervention; McKenney, Nieveen, & Van den Akker, 2006).

The studies described in this chapter drew on the multiple theoretical perspectives and research paradigms of design-based research to build understandings of the nature of and conditions for developing pre-service teachers' actual use of ICT resources to improve their mathematics teaching. A context and needs analysis and a literature review were conducted as part of the first stage of the research process. This provided empirically-based awareness about the problem in context, as well as useful information for the formulation of the initial design guidelines that shaped a professional development arrangement. Based on the context and needs analysis, a professional development programme (using collaborative design teams) to engage pre-service teachers in ICT-rich design activities was implemented in three iterations of design, implementation, evaluation and refinement. Data collection during each iteration generated information on how to refine the programme and whether the professional development programme yielded the desired impact, since design-based research integrates the development of solutions to practical problems in learning environments with the identification of reusable design principles (Reeves, 2006). Besides seeking to improve the programme, the evaluation also sought to determine the effectiveness of the technological professional development arrangement for pre-service teachers as far as improving student performance. Furthermore, a final study was conducted to ascertain the potential and conditions for transfer of knowledge and skills in the design and implementation of ICT-enhanced lessons of the pre-service teachers (who where pursuing their careers as mathematics teachers) at various senior high schools. Overall, a design-based research approach proved useful in finding realistic answers to the question posed for the research.

Description of the Studies

The first five research questions were addressed in study 1. *Study 1* investigated the feasibility of teachers' ICT use in mathematics lessons. The first part of Study 1 sought to determine the features of ICT implementation that matched the realities in SHS, and provided useful guidelines for designing a professional development arrangement for teachers' ICT integration. The second part of Study 1 searched for a better understanding of mathematics teachers' attitudes and skills related to ICT integration and their ICT access levels, and the extent to which these parameters influenced mathematics teachers' integration of ICT. A total of 180 educators consisting of 60 in-service mathematics teachers and 120 pre-service mathematics teachers participated in the study. The practicing teachers were selected from 16 SHS ranging across government, mission, private and international schools. Schools were selected because they had a reasonable number of mathematics teachers as well as some kind of ICT infrastructure. The average age of these in-service teachers was approximately 39 years old, ranging between 25 and 59. There were 52 males and only 8 females. The average teaching experience was approximately 12 years, ranging from as low as 1 year up to 37 years. The pre-service mathematics teachers were from the mathematics teacher education programme at University of Cape Coast (UCC), Ghana. Ninety-five of them were males and 25 were females; they were between 19 and 43 years old, with an average age of nearly 26. Six principals and 14 heads of departments (HoD) in the mathematics section from the 16 SHS were also involved in the study. Further, the study involved the department head of the teacher education programme and an officer from the ICT section of the Ghana Education Service (GES).

Study 2 (research questions 6 and 7), conducted in three iterations, reported results from research that explored Technological Pedagogical Content Knowledge (TPACK) as a framework for developing pre-service teachers' experiences with ICT integration. In particular, the first iteration presented results on teachers' experiences in developing and implementing ICT-enhanced lessons using collaborative design teams as an approach to professional development. Four pre-service mathematics teachers (experimental teachers) and their student peers ($N = 125$) (student-teachers) participated in the study. These experimental teachers had not had any experience with technology–supported lessons, neither as part of their training nor in their pre-university education at the SHS. The student-teachers, who volunteered to be part of the study, were 90 males and 35 females. Just like the experimental teachers, the student teachers had no prior experiences with technology-supported lessons.

The second iteration extended the arrangement of the ICT integration programme to real classroom settings. In this follow-up study, 12 pre-service mathematics teachers participated. The senior high school students ($n = 297$) who participated in the study were from three different high schools. These high school students (from years 1, 2 to 3) were taught lessons by the pre-service teachers. Two hundred twenty-five of them participated in the activity-based lessons supported with spreadsheets, while 72 of them were taught with the traditional approach and served as a control group.

Studies 3 and 4 (research questions 8, 9 and 10) integrated the findings from the previous studies and also identified some inherent conditions and challenges for large-scale implementation of technological innovations in mathematics classrooms. *Study 3* reported on a scale-up study (beyond the group case studies) of the professional development arrangement in a mathematics–specific Instructional Technology (IT) course to foster adoption of the innovation by many pre-service mathematics teachers. More specifically, strategies to develop pre-service teachers' technology integration competencies in the IT course were reported. Pre-service mathematics teachers ($N = 104$; 70 males and 34 females) participated in the study. The pre-service teachers were in their final year of the mathematics teacher education programme. The pre-service teachers had not had any experience with technology-supported lessons, neither as part of their training nor in their pre-university education. Their average age was nearly 25 years old. The participants worked in teams of four; as a result, 26 lessons (by 26 teams) were developed in the study. A random sample of eight teams was selected, whose the lessons plans and teaching try-outs were presented at the middle and at the end of the course. Another random sample of eight teams presented their end products at the end of the course. All 26 teams were involved in the self-reported survey before and at the end of the course.

In *study 4*, the extent to which beginning teachers were able to transfer knowledge and skills about designing and enacting ICT-enhanced activity-based learning activities to the real classroom situation and inherent challenges identified in this process were examined One hundred beginning mathematics teachers (66 males, 34 females) were involved in the transfer study. The beginning teachers had participated in a professional development programme during their final year at the teacher education programme at the University of Cape Coast (UCC) to design and enact ICT-enhanced activity-based learning for the first time. These teachers were currently pursuing their careers as mathematics teachers in various senior high schools. All 100 participants responded and completed a questionnaire survey that was administered through email. A random sample of 20 participants was interviewed and 6 of them were voluntarily observed to provide an authentic depiction of the way in which beginning teachers used ICT-ABL in the naturalistic setting of their classroom.

Main Findings

Needs and Context Analysis: Feasibility of ICT Use in Teaching Mathematics

At the initial stage of the research, a context and needs analysis study was conducted to explore the feasibility of ICT use in mathematics teaching in Ghana. The study involved pre-service and in-service mathematics teachers, principals from senior high schools, department heads from the teacher education programme at UCC, and a representative from the curriculum and ICT section of the Ghana Education Service. The purpose of this study was to provide an understanding of the context of mathematics teaching in the Senior High Schools (SHS) and to inform and support the development of ICT integration in the UCC teacher preparation programme. By assessing the perceptions of the various stakeholders regarding the current mathematics curriculum, especially in relation to the use of ICT, challenges and perceived barriers to integrating ICT were reported. Further, ICT training needs of mathematics teachers and existing opportunities to prepare pre-service teachers to effectively design and implement ICT in the teaching of mathematics were also reported.

Findings of the study revealed that mathematics teachers in Ghana do not integrate ICT in their mathematics instruction, and that the most frequently used pedagogical strategy by the teachers was the teacher-centred approach in which teachers do most of the talking and intellectual work, while students are passive receptacles for the information provided. Among the major perceived barriers that hindered the use of ICT were: lack of knowledge and skills about how to integrate ICT in lessons, and lack of opportunities for both pre- and in-service teachers to learn and practice ICT integration. The results also revealed that there was a major need for the development of teachers' knowledge and skills concerning the integration of ICT in mathematics education. This, however, was not part of the teacher preparatory programme at UCC. The study also revealed that senior high schools lacked common mathematical software (such as Derive, Graphic Calculus, Geometer's Sketchpad, etc.) which can be used for teaching mathematics in the classroom; however, most schools had computer labs.

In spite of the challenges, it was encouraging to find that in-service and pre-service mathematics teachers appeared generally supportive, indicating positive attitudes about using ICT as an instructional tool in their classrooms. An in-depth analysis of pre-service and in-service teachers' will (attitudes), skill (technology competency), and tools (access to technology tools) as essential ingredients for a teacher's integration of ICT into classroom practice was also conducted. The results indicated fairly low ICT competencies, with significant differences existing between pre-service and in-service teachers. The pre-service teachers in this study showed greater anxiety and were less ICT-competent than the in-service teachers. *Computer anxiety* also emerged as the most important dimension of attitudes towards ICT use, while skill was the strongest predictor of classroom integration of ICT for both pre- and in-service teachers. The results of the study suggested that increasing pre- and in-service teachers' ICT skills and decreasing their anxiety should be an integral part of the design of professional development arrangements for pre- and in-service teacher education. Recommendations could be formulated to design professional development opportunities that focus on preparing pre-service teachers to acquire skills regarding how to integrate technology effectively in their instruction, taking the context of the available ICT infrastructure into account.

Design and Implementation (First Iteration): Developing TPACK Through Collaborative Design in a Professional Development Programme

Based on the outcomes of the context and needs analysis study, a professional development programme based on 'learning technology by design' was piloted. TPACK was used as a conceptual framework to examine the knowledge and skills pre-service math teachers developed about ICT, pedagogy and content. The arrangement involved four pre-service teachers who worked collaboratively in design teams (DTs) to design and develop ICT solutions for authentic problems they face in teaching mathematics concepts. The technology learned by the pre-service teachers was spreadsheet applications, because it has the potential to support students' higher-order thinking in mathematics and is readily available. Pre-service teachers were asked to carefully choose instructional strategies they felt would be useful in supporting their lessons. Exemplary curriculum materials were used to provide pre-service teachers with theoretical and practical insights related to spreadsheet-supported lessons and with hands-on experiences. The DTs developed and modelled their own lessons after receiving the exemplary materials and subsequently taught their peers in an ICT-based environment for the first time.

Pre-service teachers' participation in collaborative design teams increased their knowledge and skills regarding the design and use of ICT-enhanced mathematics lessons. Moreover, pre-service teachers enhanced their knowledge of their subject matter and were able to make intimate connections among their specific content, pedagogy and technology in a collaborative way. Overall, the results of evaluation studies showed that collaborative design was a useful approach for pre-service teachers' development of TPACK. Along with working in DTs, the exemplary materials supported the pre-service teachers by: promoting a better understanding of what integrating technology in lessons is about, promoting pedagogical design capacity, providing concrete, how-to suggestions and facilitating better implementation of the innovation. Although the study showed the potential of TPACK to be a new framework for developing experiences for future teachers, it cannot be said that the professional development programme in the study fully developed the teachers' TPACK. Further opportunities to experience learning about the affordances of technology applications were necessary for teachers to explore additional topics and concepts in their mathematics curricula, and to further develop their TPACK. Lessons from the study supported the contention that TPACK is a useful analytic lens for studying teachers' integration of technology, content, and pedagogical knowledge and skills as they develop over time in "learning technology by design" settings.

Design and Implementation (Second Iteration): Measuring Competencies for Activity-Based Learning with Technology

The second part of the design and implementation study conducted at the same University extended the professional development programme to real classroom settings at various senior high schools. In the arrangement, spreadsheets were presented as a tool for enacting a guided activity-based pedagogical approach to teaching mathematical concepts, referred to as Activity-Based Learning (ABL). Twelve pre-service teachers participated in this second part of the study. The teachers worked in teams of two to develop and model their own spreadsheet-supported lessons for suitable mathematics topics from the SHS curriculum, based on the exemplary materials. Six activity-based mathematics lessons supported with spreadsheets were developed and enacted twice: first by teaching their peer pre-service teachers and later by teaching senior high school students.

The results indicated that the pre-service teachers enacted their lessons using an activity-based instructional approach in which spreadsheets were integrated to help students explore mathematics concepts and perform authentic tasks. In their lesson plans, and during observed instruction, the pre-service teachers demonstrated knowledge and skills by designing and enacting activity-based lessons supported with spreadsheets. This was confirmed by the self-reported development of the knowledge and skills needed to design and enact spreadsheet-supported ABL lessons as indicated by significant gains in all of the TPACK components. To assess the impact of the spreadsheet-supported ABL mathematics lessons on secondary school students' learning outcomes, two pre-service teachers taught their lesson using the spreadsheet-supported ABL pedagogical approach (experimental group) and using a common teacher-centred approach (control group). Significant differences with large effect sizes were found between pre-and post-test mean gains on a performance test in favour of students who experienced the spreadsheet-supported ABL approach compared to the teacher-centred lessons. The findings supported arguments that the spreadsheet-supported ABL approach fosters learner-centred classroom practices, is a useful pedagogical approach, and has potential for improving mathematics teaching, learning and achievement in secondary education. It was concluded that exposing teachers to activity-based learning supported with spreadsheets through collaborative design teams is a good way to help pre-service teachers develop deeper connections between their subject matter, instructional strategy and spreadsheet applications to enhance their TPACK.

Large-Scale Implementation (Third Iteration): Implementing Design Guidelines in a Mathematics-Specific Instructional ICT Course

This study reported on the integration of the professional development programme into a regular mathematics–specific instructional technology course in the mathematics teacher preparation programme of the University of Cape Coast. The design guidelines used and reported in the previous studies were applied to the design of a mathematics-specific course to develop pre-service teachers' spreadsheet integration competencies. In addition to those design guidelines, opportunities for scaffolding authentic ICT experiences were also created for pre-service teachers. The importance of authentic teaching experiences with ICT was demonstrated in teaching try-outs in which pre-service teachers put the lessons they had designed into practice. One hundred and four pre-service mathematics teachers from the teacher preparation programme at UCC enrolled in the course for one semester to develop their ICT integration competencies in teaching mathematics. As was the case in the previous studies, pre-service teachers collaborated in design teams to design spreadsheet-enhanced activity-based lessons for mathematics. Two groups of pre-service teachers were distinguished: those who were involved in trying-out (PT) their designed lessons by teaching their peers and those who did not have any experience trying-out their lessons by teaching (NPT).

Findings showed that the impact of the Instructional Technology (IT) course on the pre-service teachers' competencies for both PT and NPT was reflected in an increase in their positive attitude towards technology, their self-reported development in TPACK, and their lesson plans and lesson enactment. However, the impact of the IT course differed between pre-service teachers who were involved in the teaching try-out (PT) and those were not (NPT). Teachers involved in the teaching try-out had less anxiety and more enjoyment, a higher increase in their self-reported TPACK, and lesson plans that better reflected TPACK than pre-service teachers not involved in trying-out their lessons. The pre-service teachers involved in the lesson try-out demonstrated in their lesson plans and lesson enactment their ability to integrate technology in teaching mathematics in a sound way, much more than their peers who did not have the opportunity to teach the lesson to peers and instructors. Thus, although both groups of teachers (PT and NPT) developed and improved their competencies in the IT course, the evidence from the study showed that pre-service teachers involved in the teaching try-out developed their competencies better. One obvious reason for developed and improved competencies, particularly with the PTs, was the authentic technology experiences they acquired during the teaching try-outs. Furthermore, the contribution of feedback from their peers and the researcher during the try-out was an added advantage for improved competencies of PTs.

Transfer of Learning: Examining Factors Affecting Beginning Teachers' Transfer of Learning in Their Professional and Teaching Practice in Ghana

Approximately 6, 18, and 28 months after the third, second and first interventions, respectively, the pre-service mathematics teachers who participated in each study had taken positions in various senior high schools and were pursuing their careers as mathematics teachers. This study employed an embedded mixed-method research design to examine the extent to which 100 of the beginning teachers were able to transfer their knowledge and skills to utilise an ICT-based innovation. The ICT-based innovation consisted of two related components: (1) learning of technology by collaborative design (LTCD) (process) and (2) ICT-enhanced activity-based lessons in mathematics (ICT-ABL) (product). Based on Baldwin and Ford (1988), this study postulated transfer of learning as a function of: (1) characteristics of the ICT-based innovation; (2) beginning teachers' learner characteristics and (3) school environment characteristics. The study sought to arrive at an understanding of how these characteristics influenced transfer of learning in the teachers' professional and teaching practice.

The findings showed that the beginning teachers still hold positive pedagogical views developed during collaborative design in teams in their pre-service teacher preparation programme, and this seemed to be the most influential factor for teachers' transfer and use of the innovation. The second most influential factor affecting teachers' use of the ICT-based innovation was their learner characteristics. A significant amount of variance attributable to the teachers' learner characteristics explained differences in the level of transfer of the ICT-based innovation. The most critical learner characteristics that were reported were knowledge and skills. It was encouraging to note that most beginning teachers reported having sufficient knowledge and skills, which indicates how well the preparatory programme contributed to teachers' professional learning. School environmental factors were not a significant predictor of transfer of learning, probably because of lack of variability in the school-related factors across the schools. However, interview and observation data indicated that teachers were faced with constraints related to their school environment that contributed to lack of creativity in using certain components of the ICT-based innovation. In particular, lack of access to the ICT infrastructure and an unenthusiastic school culture were mentioned as hindering the use of ICT-ABL.

In conclusion, the study revealed that although a significant amount of variability in the transfer of learning and the utilization of the ICT-based innovation could be attributed to the teacher-related factors, the role of school environment characteristics in influencing transfer of learning in beginning teachers' professional and teaching practice must not be underrated. Further research may be needed to better explore the impact of school environment on transfer.

Discussion

Development of Pre-service Teachers' TPACK

In this research TPACK was used as a conceptual framework for thinking about how to prepare pre-service teachers for ICT integration, because it seemed to be an interesting and useful framework for better understanding what knowledge base teachers need to incorporate ICT in their teaching. TPACK is often assessed on a more generic and abstract level, measuring perceived knowledge that is not configured as specific content knowledge, specific pedagogical knowledge or specific technological knowledge, as was in the case of this research project. The research described focused particularly on the use of spreadsheet applications in enacting a guided activity-based pedagogical approach to develop pre-service teachers' TPACK for teaching mathematics. The research demonstrated that pre-service teachers' TPACK was developed as a result of the intervention. Moreover, the research provided insights about how ABL as a pedagogical approach (representing the "P" in the TPACK model) and spreadsheet applications (representing the "T") need to be designed in close relationship to each other to create a learning environment in which mathematics content could be taught. The focus on the affordance of a specific technology (spreadsheets) and a specific pedagogy (ABL) to foster higher-order thinking skills in mathematics as a specific operationalisation of TPACK is closer to Shulman's (1986) original conception of Pedagogical Content Knowledge, than the general way TPACK is used in many studies (Voogt, Fisser, Pareja Roblin, Tondeur, & Van Braak, 2012). The results of the studies reported here have shown that this specific focus helped pre-service teachers to develop deep connections between their subject matter, the instructional strategy and the ICT application, fostering their TPACK.

It appears that the explicit focus on ABL use and spreadsheets in particular raises questions as to whether the pre-service teachers will develop their TPACK in similar initiatives using other ICT applications and pedagogical approaches. It is likely that once pre-service teachers understand the context-specific strategies and representations in which new technologies are integrated (cf. Harris, Mishra, & Koehler, 2009; Koehler, Mishra, & Yahya, 2007), they will further develop knowledge and skills related to TPACK in a valid and reliable way. It is also apparent that using multiple data sources is a good way to assess pre-service teachers' TPACK. The research contributed to a better understanding of the nature of pre-service teachers' TPACK development through the multiple types of data collected: while the self-reports assessed what the pre-service teachers thought they knew about teaching spreadsheet-supported ABL lessons (cf. Alayyar, 2011; Kereluik, Casperson, & Akcaoglu, 2010), the assessment of their lesson plans and lesson enactment provided specific information and a concrete representation of what pre-service teachers could actually do with spreadsheets to develop their TPACK (cf. Alayyar, 2011).

Alongside the need to use TPACK as a conceptual framework to guide the development of pre-service teachers' knowledge and skills, it is important that teachers' attitudes towards technology integration be understood in order to appropriately determine the competencies, defined as the integration of knowledge, skills and attitudes, that pre-service mathematics teachers need to integrate technology into their lessons (cf. Farjon, Smits, & Voogt, 2019).

Collaborative Design Teams

Polly et al. (2010) indicated that among other benefits, collaborative design teams allow pre-service teachers to familiarise themselves with each other and the idea of ICT integration, and contribute to the success of curriculum design teams. The reason for adopting collaborative design teams in the current research project was to provide an opportunity for pre-service teachers to design ICT-enhanced curriculum materials to develop their knowledge and skills related to ICT integration. Collaborative design in teams helped pre-service teachers to undertake the kind of pedagogical reasoning that is necessary to effectively integrate technology in their lessons. In particular, the need to collaborate in lesson design required the pre-service teachers to share knowledge and ideas and to explicitly reason and convince their peers about issues such as why this topic could best be taught with spreadsheets, and why they expect that certain learning activities will contribute to students' learning (Tondeur, Pareja Roblin, van Braak, Voogt, & Prestridge, 2017).

The various studies demonstrated that collaborative design in teams is a viable and effective approach for learning about technology integration. The mathematics teacher education programme at UCC therefore decided to continue with this approach and currently employs collaborative design teams in the preparation of pre-service teachers to integrate technology in education.

Ownership, Transfer and Practicality

The essence of the research project was to foster effective adoption and adaptation of collaborative design in design teams to support the integration of ICT in mathematics education. To realise this, the design-based research project described here aimed to design and implement a professional development arrangement that (1) had concrete artefacts as (one of its) outputs, (2) developed ownership in pre-service teachers regarding the integration of ICT in mathematics teaching, and (3) resulted in transfer of learning to the professional and teaching practice of pre-service teachers. In view of this, the research aimed to prevent failure of implementation of the ICT-based innovation. In this realm, three concepts were considered important:

- *Ownership*, which refers to pre-service mathematics teachers and educators claiming responsibility for actions regarding collaboration in design teams to support ICT integration in teaching mathematics;
- *Transfer of learning*, referring to whether new knowledge, skills and attitudes acquired by pre-service teachers during the pre-service programme were being applied or used in their professional and teaching practice; and
- *Practicality* referring to how feasible the use of collaborative design in design teams can be to support ICT integration by teachers in the classroom situations.

The research demonstrated ownership regarding collaboration in design teams in the sense that the mathematics teacher education programme at UCC has continued with this approach in preparing pre-service teachers to integrate technology in education. Transfer of learning was demonstrated in pre-service teachers' high enthusiasm to apply the new knowledge and skills about collaborative design in design teams to support the integration of ICT in their professional and teaching practice. Findings from the transfer study showed that several months after finishing their teacher education preparatory programme, the pre-service teachers who had just begun their professional careers still held strong positive pedagogical views about collaboration in design teams to support ICT integration and made attempts to employ aspects of it in their professional and teaching practice. Finally, this research demonstrated that applying collaborative design in design teams to support ICT integration in classroom situations was challenging. Findings showed that these practicality problems resulted from a complex interaction of several variables. However, it appeared that the undermining factor had to do with the passive involvement of various stakeholders, in particular those outside the pre-service teacher preparation programme, such as principals and practicing teachers at the SHS. Although SHS principals and practicing teachers were involved in the first stage of this study, they were minimally involved in the design and implementation of the pre-service professional development programme. This might partly account for the problems pre-service teachers encountered when they, now as beginning teachers, wanted to enact what they had learned in the pre-service programme. In addition to the design of an induction programme for beginning teachers to smooth the transition from teacher preparation to teaching in practice, more attention could have been given in this research to the involvement of SHS personnel during the formative evaluations of the professional development arrangement.

Design Guidelines

One major outcome of applying design-based research in this project has been the construction of a body of design guidelines that could be used to guide future efforts to develop pre-service teachers' experiences with technology integration. Based on this research the following design guidelines have been formulated:

Collaborative Design Teams, in which pre-service teachers work with peers, are an important means to stimulate and support teacher learning. This approach to ICT integration will improve interaction and interdependence among pre-service teachers, making them discover how to share knowledge and ideas as well how to brainstorm about relevant information for their designs.

Exemplary curriculum materials are an important means to use, as they can inspire teachers to learn and provide better understanding of an innovation (cf. Van den Akker, 1988). Exemplary curriculum materials will promote a better understanding of what integrating technology in lessons is about, promote pedagogical design capacity, provide a concrete how-to suggestion and facilitate better implementation of ICT-based innovations.

For more effective collaboration during the use of the exemplary materials and working in design teams, an *orientation programme* is important. Such an orientation programme for pre-service teachers should provide a learning experience where conceptual and theoretical information can be linked to a practical application.

Adoption of technology that is readily available with the potential of supporting students' higher-order thinking in mathematics is key to a successful technology integration intervention. By learning how to use existing hardware and software in creative and situation-specific ways to accomplish their teaching goals, pre-service teachers will be prepared to use ICT in their professional and daily classroom practice.

Scaffolds and authentic technology experiences, such as teaching try-outs with peers, should be an integrated part of a pre-service teacher preparation programme aiming to develop pre-service teachers' technology integration competencies. This allows pre-service teachers to put into practice their designed lesson plans and, through feedback from peers, have access to the necessary scaffolds.

Overall, the research demonstrated that these design guidelines account for developing and improving technology integration competencies, but scaffolding *authentic technology experiences,* including feedback from teaching try-outs, makes the most significant contribution to pre-service teachers' development of technology integration competencies. Authentic teaching experiences with technology makes an important contribution to the reduction of pre-service teachers' anxieties, thereby increasing their enthusiasm to use technology in their instruction.

Conclusion

Based on the responses and experiences of the pre-service teachers, the research demonstrated that pre-service teachers developed TPACK and that they felt prepared to use ICT effectively in their classrooms. The outcomes of the research showed that collaborative design in design teams in pre-service teacher education is a viable and effective approach to prepare pre-service mathematics teachers for the integration of technology and activity-based learning in mathematics lessons. Thus, in order to *design* and *enact* ICT-enhanced mathematics lessons, opportunities were provided to develop the pre-service teachers' knowledge and skills in making intimate connections between technology (spreadsheets), content (mathematics) and pedagogy (activity-based learning). While pre-service teachers *collaborated* during design and enactment, knowledge and attitudes about ICT and activity-based learning became explicit, which helped them to reflect on their experiences, and hence fostered learning.

References

Agyei, D. D., & Voogt, J. (2011a). ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and Information Technologies, 16*(4), 423–439.

Agyei, D. D., & Voogt, J. (2011b). Exploring the potential of the will skill tool model in Ghana: Predicting prospective and practicing teachers' use of technology. *Computers & Education, 56*(1), 91–100.

Alayyar, G. M. (2011). *Developing pre-service teachers' competencies for ICT integration through design teams.* Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Anamuah-Mensah National Education Review Committee Report. (2002). *Report of the President's committee on review of education reforms in Ghana*. Accra, Ghana: Ministry of Education.

Angeli, C., & Valanides, N. (2005). Preservice elementary teachers as information and communication technology designers: An instructional systems design model based on an expanded view of pedagogical content knowledge. *Journal of Computer Assisted Learning, 21*, 292–302.

Association of Mathematics Teacher Educators. (2006). *Preparing teachers to use technology to enhance the learning of mathematics.* Retrieved from http://www.amte.net on August 12, 2008.

Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology, 41*, 63–105.

Barab, S. A., & Squire, K. D. (2004). Design-based research: Putting our stake in the ground. *Journal of the Learning Sciences, 13*(1), 1–14.

Beauchamp, G., & Parkinson, J. (2008). Pupils' attitudes towards school science as they transfer from an ICT-rich primary school to a secondary school with fewer ICT resources: Does ICT matter? *Education Information Technology, 13*, 103–118.

Becker, H. J. (2001). *How are teachers using computers in instruction?* Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA.

Bottino, R. M., & Robotti, E. (2007). Transforming classroom teaching and learning through technology: Analysis of a case study. *Educational Technology & Society, 10*(4), 174–186.

Churchill, D. (2004). Effective use of technology for construction of learners' mental models. In A. Khoo, M. A. Heng, L. Lim, & R. P. Ang (Eds.), *Innovation and diversity in education* (pp. 207–223). Singapore, Singapore: McGraw Hill (Asia).

Churchill, D., & Wong, P. (2002, November). *Design of activity-based eLearning.* Paper presented at the International Conference on Information and Communication Technologies in Education, Badajoz, Spain.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9–13.

Farjon, D., Smits, A., & Voogt, J. (2019). Technology integration of pre-service teachers explained by attitudes and beliefs, competency, access, and experience. *Computers & Education, 130*, 81–93.

Ghana ICT4AD Policy. (2003). *A policy statement for the realization of the vision to transform Ghana into an information-rich knowledge-based society and economy through the development, deployment and exploration of ICT's within the economy and society*. Accra, Ghana: Ministry of Education.

Guerrero, S. (2010). Technological pedagogical content knowledge in the mathematics classroom. *Journal of Digital Learning in Teacher Education, 26*(4), 132–139.

Harris, J., Mishra, P., & Koehler, A. M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Research on Technology in Education, 41*(4), 393–416.

Hartsell, T., Herron, S., Fang, H., & Rathod, A. (2009). Effectiveness of professional development in teaching mathematics and technology applications. *Journal of Educational Technology Development and Exchange, 2*(1), 53–56.

Haughey, M. (2002). *Canadian research on information and communications technologies: A state of the field.* Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.84.998&rep=rep1&type=pdf

Keating, T., & Evans, E. (2001). *Three computers in the back of the classroom: Pre-service teachers' conceptions of technology integration.* Paper presented at the Society for Information Technology & Teacher Education International Conference, Norfolk, VA.

Kereluik, K., Casperson, G., & Akcaoglu, M. (2010). Coding pre-service teacher lesson plans for TPACK. In D. Gibson & B. Dodge (Eds.), *Proceedings of the society for information technology & teacher education international conference 2010* (pp. 3889–3891). Chesapeake, VA: AACE.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Koehler, M., & Mishra, P. (2008). Introducing TPCK. In AACTE Committee on Innovation and Technology (Ed.), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3–29). New York: Routledge.

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education, 49*, 740–762.

MacDonald, R. J. (2008). Professional development for information communication technology integration: Identifying and supporting a community of practice through design-based research. *Journal of Research on Technology in Education, 40*(4), 429–445.

McKenney, S. E., Nieveen, N., & Van den Akker, J. J. H. (2006). *Design research from a curriculum perspective*. New York: Routledge.

Ministry of Education Science and Sports. (MOESS). (2007). *Teaching syllabus for mathematics*. Accra, Ghana: Ministry of Education.

Ministry of Education. (MOE). (2000). *Teaching syllabus for mathematics*. Accra, Ghana: Ministry of Education.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Mullis, I. V. S., Martin, M. O., & Foy, P. (2008). *International mathematics report: Findings from IEA's trends in International Mathematics and Science Study at the fourth and eighth grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Niess, M. L., Sadri, P., & Lee, K. (2007). *Dynamic spreadsheets as learning technology tools: Developing teachers' technology pedagogical content knowledge (TPCK)*. Paper presented at the Annual Meeting of the American Educational Research Association Annual Conference, Chicago, IL.

Ottevanger, W., Van den Akker, J. J. H., & de Feiter, L. (2007). *Developing science, mathematics and ICT education in sub-Saharan Africa (SMICT): Patterns and promising practices*. Paper presented at the World Bank Working Paper.

Polly, D., Mims, C., Shepherd, C. E., & Inan, F. (2010). Evidence of impact: Transforming teacher education with Preparing Tomorrow's Teachers to Teach with Technology (PT3) grants. *Teaching and Teacher Education, 26*, 863–870.

Reeves, T. (2006). Design research from a technology perspective. In J. J. H. Van den Akker, K. Gravemeijer, S. E. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 52–66). New York: Routledge.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*, 4–14.
Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*, 1–22.
So, H. J., & Kim, B. (2009). Learning about problem based learning: Student teachers integrating technology, pedagogy and content knowledge. *Australasian Journal of Educational Technology, 25*(1), 101–116.
Tondeur, J., Pareja Roblin, N., van Braak, J., Voogt, J., & Prestridge, S. (2017). Preparing beginning teachers for technology integration in education: Ready for take-off? *Technology, Pedagogy and Education, 26*(2), 157–177. https://doi.org/10.1080/1475939X.2016.1193556
Van den Akker, J. (1988). The teacher as learner in curriculum implementation. *Journal of Curriculum Studies, 20*(1), 47–55.
Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (Eds.). (2006). *Educational design research*. London: Routledge.
Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2012). Technological pedagogical content knowledge – a review of the literature. *Journal of Computer Assisted Learning*. https://doi.org/10.1111/j.1365-2729.2012.00487
Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5–23.

Part V
Sustainability of Curriculum Innovations: Editorial Introduction

Curriculum Innovation: Continuation, Sustainability and Up-Scaling

Curriculum innovation does not only pertain to effective design, development and implementation. In order to be effective its continuation after the project has finished as well as the possibilities for scaling to new contexts are also relevant. The different studies presented in this section, carried out in different countries, address issues of sustainability and scaling across diverse collaborative curriculum design projects.

The three studies reported in the first chapter of this section by Marie Bakah, Kassimu Nihuka and Anto Arkato Gendole seek the perspectives of teachers and school leaders on the sustainability of design teams in higher education. The first study pertains to the sustainability and scalability of teacher design teams in Ghana's polytechnics. The second study investigated opportunities and challenges for large-scale implementation of e-learning by providing professional development for instructors through collaborative design at the Open University of Tanzania. Finally, the third study reports on the continued use of core elements of a collaborative professional development program for communicative language in Ethiopia. Data were collected among teachers who participated in design teams, non-participating teachers and management, between 6 and 18 months after the first implementation of teacher design teams. The main findings of the three studies are presented. Opportunities for sustainability and implications of scaling up collaborative curriculum design in teacher design teams as a strategy for professional development and curriculum innovation are described and discussed.

The study presented in the chapter by Nabeel Albashiry is a synthesis of four sub-studies on the need for curriculum leadership to enable sustainable and collaborative curriculum design practices. The study was conducted in the context of Technical Vocational Education and Training (TVET) and the emergence of Community Colleges as TVET institutions in Yemen. Academic departments in these institutions, particularly the Heads of Departments (HoDs) are increasingly expected to lead curriculum (re-)design processes. This study elaborates on the concept of curriculum leadership and the competencies needed by HoDs to lead and sustain systematic and collaborative curriculum design activities within their departments. A two-round professional development arrangement was designed and implemented to support HoDs in achieving these expectations.

The focus of most professional development projects is on achieving effects that will continue some years after the project's termination. However, such effects are often not studied. The two studies reported in the third chapter of this section by Douglas Agyei and Ayoub Kafyulilo were conducted to investigate the extent to which pre-service and in-service teachers continued to use technology in teaching after the professional development arrangement had ended. Technological Pedagogical Content Knowledge (TPACK) as a conceptual framework informed the content of the professional development program, while Learning Technology by Design shaped its approach. The findings of the two studies show that (pre-service) teachers contended that their participation in the professional development arrangement had broadened their view on teaching with technology; however, for (pre-service) teachers to understand and develop knowledge and skills related to TPACK in a valid and reliable way, it is important for them to focus on a specific content as well as a specific pedagogical approach in which a specific technology can be integrated. Continued use of technology was challenged by curriculum characteristics as well as school context and culture.

Chapter 18
Fostering the Sustainability and Scalability of Curriculum Innovations Through Collaborative Design

Marie A. B. Bakah, Kassimu A. Nihuka, and Arkato Gendole Anto

Introduction

The premise behind collaborative curriculum design in teacher teams is that it is an effective strategy for teachers' professional development and sustainable innovation of curricula (Voogt, Pieters, & Handelzalts, 2016). In this chapter three small-scale studies in higher education are presented in which teachers collaboratively (re-)designed their curricula in teams. As researchers involved in the three studies, we wanted to know whether and why the teacher design teams that participated in the respective studies continued to exist, and whether their products (the curricula) were still in use. In addition, we were interested in the factors that contributed to whether the teams continued or not and the potential for scaling up the approach within the respective institutions. This chapter discusses these three studies, which focused on examining the sustainability and scalability of teacher design teams in different contexts. We conceptualized sustainability as the continuation of teacher design teams in terms of the approach (collaborative design in teacher teams) and the use of the materials produced by the design teams (courses, teacher guides, hand-outs, etc.). We conceptualized scalability as the expansion of teacher design teams within the institution.

The context of the first study involved updating the curriculum of polytechnics in Ghana, the second study's context involved the implementation of e-learning in the

M. A. B. Bakah (✉)
Institute for Educational Planning & Administration, University of Cape Coast, Cape Coast, Ghana
e-mail: mbakah@ucc.edu.gh

K. A. Nihuka
Institute of Adult Education, Dar es Salaam, Tanzania
e-mail: kassim.nihuka@out.ac.tz

A. G. Anto
School of Graduate Studies, Arba Minch University, Arba Minch, Ethiopia

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_18

Open University of Tanzania, and the third study addressed the implementation of communicative English language teaching at a university in Ethiopia. The main question for all three studies concerned the potential sustainability and scalability of teacher design teams, the effects on professional development of its members and the contribution to educational change.

Theoretical Underpinnings

Sustainability

The term sustainability implies the continuation of a programme in some way. Stoll, Bolam, McMahon, Wallace, and Thomas (2006) used sustainability to represent elements of continuous growth that are necessary for change, where emphases can include whether the focus is on continuation of the benefits of the programme to the stakeholders/participants; the perseverance of the new initiative itself; or the process of developing local capacity to enable a programme to be maintained at the stakeholder/institution level. Sustainability may constitute a distinct stage of programme development in recognition of particular requirements for sustained use in the areas of, for example, training (Elias, Zins, Graczyk, & Weissberg, 2003; Osganian, Parcel, & Stone, 2003). It has also been suggested that the process of programme development (including sustainability) cannot be understood in isolation from the context in which the programme is operating (Goodson, Murphy-Smith, Evans, Meyer, & Gottlieb, 2001; Harvey & Hurworth, 2006). From this position, actions undertaken to initiate sustained use are mediated through the different structures and practices within individual settings and so create a unique set of factors for establishing sustainability. Further, it has been indicated that the necessary conditions required for sustainability need to be planned for at the early stages of programme development (Paine-Andrews, Fisher, Campuzano, Fawcett, & Berkley-Patton 2000). Therefore, these understandings tend to suggest that sustainability may develop from a more interactive relationship between the different stages of programme development and may not be based on a simple linear process (Harvey & Hurworth, 2006).

From a more general perspective, sustainability of educational innovations involves maintaining improvement over time, learning gains for everyone and not just a few, support by attainable or available resources and opportunities for diverse solutions and flexibility (Hargreaves & Fink, 2000). On a system level, the sustainability of a professional development programme is demonstrated by the extent to which the professional development concept is accepted and implemented by different schools in an administrative region persistently (Todorova & Osburg, 2009). Necessary conditions for sustainability are the participation in the programme of a large proportion of the teachers in schools, teachers' positive attitudes and satisfaction with the professional development programme, availability of support and transfer of the goals, content and methodology of the programme (Todorova & Osburg, 2009).

Scaling Up

After decades of intense educational reform, educators, policymakers, and researchers still grapple with the question of how pockets of successful reform efforts might be "scaled up." Most research on scalability tends to define what it means to "scale up" an external reform in quantitative terms, focusing on increasing the number of teachers, schools, or districts involved (Coburn, 2003; Datnow, Hubbard, & Mehan, 2002; Hargreaves & Fink, 2000; Legters, Balfanz, Jordan, & McPartland, 2002). Stringfield and Datnow (1998) defined scaling up as 'the deliberate expansion to many settings of an externally developed school restructuring design that previously has been used successfully in one or a small number of school settings' (p. 271). Despite this simple definition, Coburn (2003) stated that it says nothing about the nature of the change envisioned or enacted or the degree to which it is sustained, or the degree to which schools and teachers have the knowledge and authority to continue to grow the reform over time. While the idea of sustainability is fundamental to scale-up, few conceptualizations address it explicitly. It only rarely appears in theoretical and empirical pieces (McLaughlin & Mitra, 2001). Most discussions address issues of sustainability and scalability separately, obscuring the way that scalability, in fact, depends upon sustainability (Coburn, 2003). There is ample evidence that sustainability may be the central challenge of bringing reforms up to scale. Schools that successfully implement reforms find it difficult to sustain them in the face of competing priorities, changing demands, and teacher and administrator turnover (Berends, Bodilly, & Kirby, 2002; Hargreaves & Fink, 2000; Hatch, 2000; McLaughlin & Mitra, 2001). Scaling up involves adapting an innovation that is successful in a local setting to effective usage in a wide range of contexts (Dede, 2006). In contrast to experiences in other sectors of society, scaling up successful programmes is very difficult in education (Dede & Honan, 2005). Scalable designs for educational transformation must avoid what Wiske and Perkins (2005) term the 'replica trap': the erroneous strategy of trying to repeat everywhere what worked locally, without taking account local variations in needs and environments. For example, the one-size-fits-all model does not fit when scaling up in education, because a pedagogical strategy that is successful in one particular classroom setting with one particular group of students frequently will not succeed in a different classroom with different students. This suggests the need for a renewed and vigorous dialogue, not just about the challenges of sustainability, but about strategies for providing schools with the tools they will need to sustain the reform (Coburn, 2003). Dede and Honan (2005) identify four key themes in adapting an educational innovation that is success in some local setting to effective usage in wide range of contexts:

1. *Coping with change:* context, leadership, and funding.
2. *Promoting ownership:* building constituent support; institutionalizing innovations.
3. *Building human capacity:* working with collaborators and partners; providing professional development.
4. *Effective decision making:* interpreting data; creating and applying usable knowledge.

In the context of innovations in teaching/curriculum, Coburn (2003) describes scalability as encompassing four interrelated dimensions: depth, sustainability, spread, and shift in reform ownership. "Depth" refers to deep and consequential change in classroom practice, altering teachers' beliefs, norms of social interaction, and pedagogical principles as enacted in the curriculum. "Sustainability" involves maintaining these consequential changes over substantial periods of time, and "spread" is based on the diffusion of the innovation to large numbers of classrooms and schools. "Shift" requires districts, schools, and teachers to assume ownership of the innovation, deepening, sustaining, and spreading its impacts. A fifth possible dimension to extend Coburn's framework is "evolution," in which the innovation as revised by its adapters is influential in reshaping the thinking of its designers, creating a community of practice that evolves the innovation (Dede, 2006). The explicit focus on sustainability as a key element of scalability also has implications for research design (Coburn, 2003). Other studies in the literature on scalability employ designs that sample schools with a range of years of experience participating in the reform (Datnow, Borman, & Stringfield, 2000). In particular, design for sustainability centres on the issue of contextual variation and involves designing educational innovations to function effectively across a range of relatively inhospitable settings (Dede, 2006). Placing reform ownership as a central element of scalability raises the priority for directing reform attention and resources to strategies that have the potential for enabling schools and districts to assume ownership of the reform over time (Coburn, 2003).

Factors Affecting Sustainability and Scalability

Factors required for successful scaling up of an innovation resemble factors that are important for sustainability of innovations (Fullan, 2007; Hoven, 2000; Means & Penuel, 2005; Sife, Lwoga, & Sanga, 2007). These factors can be categorized as: external factors outside the control of the organisation, institutional factors and conditions related to internal adoption (Ten Brummelhuis, 1995).

External factors are factors outside the control of the organization and difficult to alter by the organization. State and national policies are among the external factors that may promote or hinder the implementation, continuation and scalability of an innovation such as collaborative design in teacher teams (Guskey, 2000; Hord & Summers, 2008).

Institutional factors refer to the existence of organizational policies supporting the proposed innovation, the arrangement of professional and administrative assistance for the teachers, and resources and strategies for monitoring the implementation. There needs to be a careful alignment between different management levels and between the management and the majority of the instructors regarding implementation of the innovation (Dexter, 2007; Fullan, 2007). According to Fullan (2007), the management is in a position to shape the organizational conditions, such as the development of shared goals and the climate for collaboration. Having management that foresees and provides appropriate professional development for instructors is also essential for effective sustainability and scaling up of an innovation (Arabasz & Baker, 2003; Joint, 2003). According to Walker and Johnson (2008), training should be regularly provided so as to accommodate new and inexperienced instructors.

Conditions for internal adoption refer to relevance, readiness, and resources (Fullan, 1991). Relevance refers to stakeholders' opinions about the importance of the innovation. The way the teachers perceive the *relevance* of a professional development program affects their sense of ownership of the program, and this perception enhances or limits the teachers' interest in learning about the program and in using it as intended in their classroom teaching practices (Elias et al., 2003). The goals of a professional development effort should be worthwhile for stakeholders (Guskey, 2000). *Readiness* includes the stakeholders' potential ability to implement and continue an innovation, including the necessary knowledge, attitudes and skills of individual practitioners (Steyn, 2005), Instructors' positive attitude contributes to their willingness and in fact is key to the sustainability and scalability of an innovation (Walker & Johnson, 2008). The issue of instructors' perceptions of the practicality of the innovation is similarly crucial (Doyle & Ponder, 1978). *Resources* represent the availability of the financial support, time, equipment and materials required to realize the intended change. Effective support for instructors plays a role in the sustainability and use of innovations (Sife et al., 2007). With support, instructors find scaling up of innovation, such as e-learning, easier and more interesting (Walker & Johnson, 2008). Lim and Khine (2006) found that instructors are more likely to be motivated both intrinsically and extrinsically if they are offered incentives. Incentives include providing monetary rewards, reducing the workload of instructors (Leem & Lim, 2007), providing materials, such as a laptop (Stoltenkamp, Kles, & Njenga, 2007), and opportunities for educational scholarship and professional development (Brent, Felder, Hirt, Sitzer, & Holzer, 1999). Steyn (2005) contended that availability of resources enabling teachers to effectively implement the innovation in their classroom practices is considered an essential factor for continued use of program as intended. In particular, an appropriate ICT infrastructure is required in e-learning innovations (reported in the second study). This implies access to computers, internet, learning management systems, e-mail and mobile phones, and so forth (Sherry & Gibson, 2002; Siritongthaworn, Krairit, Dimmitt, & Paul, 2006). Challenges such as narrow bandwidth, unreliable and frequent power outages (Cuban, Kirkpatrick, & Peck, 2001; Gakio, 2006; Siritongthaworn et al., 2006) also interfere with the sustainability and scalability of e-learning innovations.

Study 1: Ghana: Collaborative Curriculum Re-design of the Polytechnic Curriculum

Context

In 2007, polytechnic institutions in Ghana became higher institutions of vocational learning by law, and could offer Bachelor of Technology programs as well as Higher National Diplomas. As a result, Ghanaian polytechnics embarked on rigorous curriculum reform. A major challenge faced by the polytechnics was the professional development of teachers, as curriculum design became their responsibility. This study employed a collaborative approach to curriculum design to support teachers in redesigning the curriculum. The use of collaborative curriculum design was used in this study due to its workable, cohesive and interactive nature and as an effective professional development strategy among teachers. Two iterations of the intervention were developed and tested. The intervention lasted 12 weeks and consisted of an introduction and dissemination workshop, design meetings to update courses, visits to industry sites and a teaching try-out.

The impact study focused on the sustainability and the potential for large-scale implementation of design teams in the two polytechnics studied. This sustainability study was conducted 18 months after implementation of the first intervention study and 8 months after implementation of the second intervention study. Teachers ($n = 29$) participating in the intervention, teachers not participating in the intervention ($n = 34$) and management ($n = 8$) shared their insights and reflections on the programme and the way ahead for teacher learning in the polytechnic. Data collection took place though a questionnaire, individual interviews and focus group interviews.

Main Findings

The results showed that teachers continued to collaborate in design teams for curriculum design and professional development and that new design teams had started in other departments. The continuation of the existing design teams (sometimes with new members joining the team) and the formation of new design teams in other departments indicate the potential for sustainability and scalability of teacher design teams within Ghana's polytechnics. Leaders' activities and behaviours were identified as supporting the sustainability of design teams. The findings showed that scaling up design teams within the polytechnics seemed promising due to supportive factors such as the maintenance and expansion of original design teams and staff awareness and commitment within the institutions. The sustainability of design teams in the long run, however, needs to be better regulated and incorporated in the polytechnic structure (institutional factors). Some identified inherent opportunities for supporting sustainability are outlined and conclusions drawn based on the characteristics of the programme, contextual features and polytechnic climate. An opportunity presented by collaborative design in teacher teams is that working collaboratively on authentic design tasks holds prospects for teachers to address their learning needs (internal adoption conditions). The characteristics of the programme also contributed to the continued use of design teams. For instance, the underlying design of design teams emphasised teacher and leadership involvement and ownership, identification of learning needs, links with existing policies and structures regarding curriculum design and an already recognised need for teacher development to support the polytechnic reform process. Using evidence-based research promoted the understanding of best practices in teamwork among teachers, together with current knowledge about design team usage for collaborative curriculum design. The already collegial relationship that characterises design teams enhanced a normative change and provided continuing opportunities to learn.

Study 2: Tanzania: Collaborative Course Redesign to Support E-Learning Implementation

Context

Distance education at the Open University of Tanzania (OUT) is dominated by a print-based mode of delivery. Because of that, several challenges confront instructors and students at OUT, which include (i) delays in the delivery of print study materials, course outlines and learning resources; (ii) lack of regular interaction between instructors and students; (iii) lack of immediate feedback on student learning and (iv) feelings of isolation among students.

Studies from developed countries show that e-learning technologies are used in distance education to enhance the delivery of courses, facilitate access to resources, improve interactions with students and provide feedback and support to students (e.g., Ludwig-Hardman & Dunlap, 2003; Pena-Bandalaria, 2007). Recognizing the potential of e-learning, in 2004, OUT embarked on supporting instructors' professional development through workshops. Despite the workshops, instructors at OUT continued to deliver their courses traditionally. *Collaborative Course Design* in design teams was applied as a strategy for effective professional development in preparing instructors regarding course (re-)design and delivery of courses using the Moodle learning management system. *Collaborative Course Design* had the following characteristics: active participation of instructors, maintenance of activities over a long period of time, opportunities for collaboration within and between design teams and support for instructors. In this way instructors' ownership of e-learning was promoted, which was assumed to contribute to e-learning implementation at OUT. Two iterative cycles of Collaborative Course Design were implemented during a 2-year period.

The impact study investigated the feasibility for incorporating collaborative curriculum design as a strategy for professional development of instructors regarding e-learning implementation within OUT at a larger scale. Five representatives from the management participated in the study, including the vice-chancellor, four deans and one director. Fifteen instructors who participated in collaborative curriculum design during the pilot and implementation study and 20 instructors not previously involved in collaborative curriculum design participated in the study. Data collection through interviews and a questionnaire took place 6 months after the last cycle of Collaborative Course Design.

Main Findings

Findings revealed that several opportunities made the implementation of large-scale collaborative curriculum design at OUT to support instructors regarding e-learning implementation at a large scale feasible. The management at all levels was committed to and interested in e-learning course delivery, found it useful and felt that it contributed to the improvement of students' enrolment and access to distance education. The university had in place an ICT steering committee that included deans and directors as members; the university was also introducing the positions of deputy vice-chancellor in charge of learning technologies and director of educational technology (institutional factors). There existed a comprehensive ICT policy, an ICT master plan and an ICT implementation strategy, which were well aligned to the rolling strategic plan of the university (institutional factors). Results also showed that there was (limited) access to technologies such as computers, internet, phones, printers and photocopiers for instructors in the university. Moreover, the university had in place an incentive scheme which included awards of $500, a recognition letter and/or covering expenses to participate in an e-learning conference. There was also centralized technical support within OUT (conditions for internal adoption).

Several challenges were identified that need the attention of the management in order to make scaling up of collaborative curriculum design effective and sustainable at OUT. These include needs for more shared goals regarding e-learning course delivery so that instructors in faculties and institutes consider e-learning as a priority, and alignment of different management levels with instructors in faculties/institutes so that e-learning implementation plans are reflected in the action plans of faculties and institutes (conditions for internal adoption). Other challenges are limited access to technologies, narrow bandwidth, unreliable electricity and lack of well-structured pedagogical support at the university (conditions for internal adoption).

It was concluded that the available opportunities are likely to support large-scale implementation of collaborative curriculum design for large-scale implementation of e-learning at OUT.

Study 3: Ethiopia: Collaborative Teacher Professional Development for Communicative Language Teaching

Context

In Ethiopia, where English serves as a medium of instruction in secondary and higher education, the quality of English teaching is challenged due to a vast and rapid educational expansion and limited teacher quality in higher education. Given the large number of students attending higher education, universities cannot attract sufficient well-qualified academic staff and are compelled to recruit many under-qualified English language teachers at the bachelor level who have little or no pre-service teacher education and prior teaching experiences. Instruction by under-qualified English language teachers is believed to negatively affect students' English language learning. In addition, the command of English of most students enrolling in higher education is inadequate. Students need to use the English language for daily communication purposes, and therefore they need to learn the language in an interactive way, which is fostered by a student-centered approach to language teaching. Moreover, in line with the existing educational reform, which calls for the use of student-oriented teaching methods, the universities need to move the teachers from a predominantly teacher-dominated language teaching approach to interactive student-centred language teaching that encourages students to use the language for meaningful daily communication purposes. Communicative language teaching (CLT) is widely accepted and believed to be effective in enabling students to learn a language for their authentic communication in an interactive way. The main purpose of this study was to design and implement a collaborative professional development program (CPDP) that would enable Ethiopian higher education English language teachers to enhance their CLT knowledge and practices. Two iterative cycles of the CPDP were developed and implemented over a period of 2 years at Arba Minch University.

A cross-sectional mixed method design was used. Teachers participating in CPDP (PT, $n = 16$), non-participating teachers (NPT, $n = 23$), facilitators ($n = 3$) and the management ($n = 2$) provided data for the study. The non-participating teachers included teachers who did not participate in the formal implementation of the professional development program, but taught the course *Communicative English Skills* assisted by the products of the CPDP: the teacher guides, the CLT hand-out and the revised learner materials.

Main Findings

With regard to the external conditions, the study found that the government did formulate policies to encourage in-house professional development of teachers at Ethiopian universities. These policies laid good groundwork for continued use of the CPDP elements, as policies create a framework for action. Universities, however, have paid limited attention to these initiatives and focused on making the teachers pursue further study to obtain higher qualifications. Fortunately, the college dean demanded that teachers participate in ongoing professional development and that the CPDP be included in the English Language Improvement Program. This means that there will be sufficient managerial support to continue using the CPDP elements.

From the perspective of conditions for internal adoption, teachers, facilitators and management perceived CPDP as a relevant program and all PTs and NPTs found the hand-out, the teacher guides and teacher collaboration relevant. PTs perceived the hand-out as more relevant than NPTs did, a statistically significant difference. Teachers used the CLT hand-out and the teacher guides in more than half of their lessons. PTs were found to use these materials better than NPTs, but the difference was not significant. The PTs' better perception of the CLT hand-out and better use of the handout and the teacher guide can be explained by the fact that PTs had better exposure to the materials during their CPDP training sessions. Possibly because of experiencing collaboration during the actual CPDP implementation, PTs continued to use teacher collaboration better than NPTs did after the termination of the program. NPTs showed greater variability (larger standard deviations) in their perceptions and use of the CLT hand-out and teacher guides than did PTs. This can be attributed to greater variability in qualifications and teaching experience among NPTs compared to among PTs. To support teachers in their CLT practice, audio materials, learner materials, the teacher guides and the CLT hand-out designed in the previous studies were further developed and made available for use. However, lack of up-to-date books, magazines and journals on CLT and a dysfunctional language lab hampered CLT implementation.

The study shows that teachers are ready to receive and provide assistance (institutional factors) in enhancing their CLT application. Facilitators expressed their willingness to take up their leadership roles if the management arranges for it (e.g., allocating time, extra payment). Stakeholders suggested different strategies to continue and extend peer support as a means to enhance CLT teaching practice. These strategies included: (1) arranging training on peer coaching, (2) regular monitoring and evaluation of the peer coaching processes by facilitators, (3) preparing experienced teachers (facilitators) to train teachers on various aspects of peer coaching, (4) pairing up teachers teaching similar courses, (5) making it possible for teachers to share similar offices, (6) providing necessary materials, (7) allocating sufficient time, (8) recruiting professional development leaders and facilitators, and (8) providing financial rewards for staff involved in various professional development undertakings.

The study further reveals that the college plans to put the CPDP under the English Language Improvement Program (ELIP) to continue the program. The department head had the learner materials for the course *Communicative English Skills* revised and sent the learner materials, the hand-out and the teacher guide to the teachers. In addition, a committee monitoring teachers' use of the materials has been established, and laptops have been provided to teachers lacking their own to teach listening skills.

To conclude, the CPDP has made important contributions to the professional development of English language teachers at Arba Minch University. First, English language teachers perceive the materials (hand-out and teacher guides) developed as part of the CPDP to support them in their teaching as relevant and they are ready to use them. The absence of a significant difference between PTs and NPTs in terms of their perception and effective use of most of the CPDP elements implies that the program and its elements are useful for both teacher groups for successful learning and implementation of CLT. The importance of reading materials (Joyce & Showers, 2002), teacher guides (Thijs & Van den Berg, 2002) and concrete resources such as audio texts (Richards & Farrell, 2005) as part of professional development has also been found in other studies, in which they are seen as productive tools to enhance teachers' professional learning and facilitate curriculum enactment (Garet, Porter, Desimone, Birman, & Yoon, 2001). Second, English language teachers are open to initiatives that encourage teacher collaboration and peer support, to enhance their CLT skills further. These findings indicate that teachers feel committed to the implementation of CLT (Fullan, 2007). The better use of teacher collaboration by PTs than NPTs implies that in order to use collaboration in their teaching practices effectively, teachers should participate in a professional development initiative in which collaboration is an integral part. Third, the importance put on continuing professional development in national and university policies offers opportunities to develop strategies to promote teacher collaboration and peer support as professional development strategies for English language teachers. These findings suggest that bottom-up and top-down strategies to support the implementation of CLT are in balance (Fullan, 2007).

For continuing use of the CPDP elements, it is crucial to have in place a system embedded at the university that is responsible for: (a) keeping the teacher guides and the hand-out up to date, (b) distributing these materials to teachers, (c) encouraging and scaffolding teachers to collaborate and support each other in their classroom teaching. Other universities in the country could model this system.

Reflections

The three studies presented in this chapter have shown that teacher design teams contribute to sustainable outcomes and have potential for scaling up of curriculum innovations and teacher professional development. In all three studies, the products of teacher design teams were still in use; in two of the three studies (at Ghana's Polytechnics and the Open University of Tanzania) teacher design teams had also continued to exist as an approach to professional development and curriculum innovation. Scaling up of the approach was considered feasible in Ghana's polytechnics and the Open University of Tanzania.

Teachers' appreciation of collaboration as a means to encourage teacher learning through collaborative discussion, sharing and reflection on their common issues and practical experiences is consistent with the views of many scholars (Harvey &

Hurworth, 2006; Little, 1990) who take teacher collaboration as a vital instrument for enhancing teacher learning. Most teachers had a clear commitment to continual improvement and saw the design teams as a useful means for this process. Despite this fact, the teachers at the Open University in Tanzania and at Arba Minch University in Ethiopia mentioned that they engaged in limited practice of collaboration, which they attributed to a shortage of common time to get together and jointly carry out these activities. The poor culture of collaboration among teachers could threaten the sustainability of teacher design teams (Fisher & Swindells, 1998). We are, however, conscious of the fact that the process of re-culturing is a long-term journey, as evidenced by the time, energy and resources exerted to move from implementation to sustainability.

Committed management, conducive institutional conditions and support structures fostered the continuation of teacher design teams at the Open University of Tanzania and Ghana's polytechnics. The most important supportive contextual feature for sustained design team use generally involved the leaders' support. The teachers' enthusiasm was boosted when some leaders encouraged the formation of new design teams in Ghana's polytechnics. External conditions hampered the continuation of teacher design teams in Ethiopian universities. An important reason was that the universities pressured teachers to obtain higher qualifications outside the university, leaving little room for in-house professional development. However, the outcomes of teacher design teams at the Ethiopian university, the learner material for the course *Communicative English Skills,* was provided to the teachers. In addition, a committee monitoring teachers' use of the materials has been established, and laptops have been provided to teachers lacking their own to teach listening skills. At the Open University the non-existence of (e-learning) action plans at the level of faculties/institutes indicates a need for better alignment between plans at university and faculty/institute level, which is necessary for teacher design teams to be sustainable in the long run. Similarly, the need to incorporate teacher design teams in the policy structure of Ghana's polytechnics also shows the vulnerability of the innovation at the department and institution level.

The underlying design of design teams emphasised teacher and leadership involvement and ownership, identification of learning needs, links with existing policies and structures regarding curriculum design and an already recognised need for teacher development to support the polytechnic reform process. An additional feature that also appeared to assist with the continued use of design teams was the use of evidence-informed research in the development of the programme. Understandings of best practices in teamwork among teachers were combined with current knowledge about usage of design teams for collaborative curriculum design. The use of this broad theoretical underpinning appeared to strengthen the specific design of the strategies for planning and implementing collaborative curriculum design through design teams. The components of collaborative curriculum design were set within a purposeful and tangible process of curriculum reform in all three contexts.

References

Arabasz, P., & Baker, M. (2003). *ECAR respondent summary: Evolving campus support models for e-learning courses*. Retrieved May 12, 2006, from http://www.educause.edu/ir/library/pdf/ERS0303/ekf0303.pdf

Berends, M., Bodilly, S., & Kirby, S. N. (2002). *Facing the challenges of whole-school reform: New American schools after a decade*. Santa Monica, CA: Rand.

Brent, R., Felder, R. M., Hirt, D., Sitzer, D., & Holzer, S. (1999). *A model program for promoting effective teaching in colleges of engineering*. Proceedings of the 1999 annual ASEE meeting, ASEE, June, 1999.

Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher, 32*(6), 3–12.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technology in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal, 38*(4), 813–834.

Datnow, A., Borman, G., & Stringfield, S. (2000). School reform through a highly specified curriculum: Implementation and effects of the core knowledge sequence. *The Elementary School Journal, 101*(2), 167–191.

Datnow, A., Hubbard, L., & Mehan, H. (2002). *Extending educational reform: From one school to many*. London: Routledge/Falmer.

Dede, C. (2006). Scaling up: Evolving innovations beyond ideal settings to challenging contexts of practice. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 551–566). Cambridge, UK: Cambridge University Press.

Dede, C., & Honan, J. P. (2005). Scaling up success: A synthesis of themes and insights. In C. Dede, J. P. Honan, & L. Peters (Eds.), *Scaling up success: Lessons learned from technology-based educational improvement* (pp. 227–239). New York: Jossey-Bass.

Dexter, S. (2007). *Show me the leadership: The impact of distributed technology leadership teams' membership and practices at four laptop schools*. Paper presented at the 88th Annual Meeting of the American Educational Research Association, Chicago, IL.

Doyle, W., & Ponder, G. (1978). The practicality ethic in teacher decision making. *Interchange, 8*(3), 1–12.

Elias, M. J., Zins, J. E., Graczyk, P. A., & Weissberg, R. P. (2003). Implementation, sustainability, and scaling up of social-emotional and academic innovations in public schools. *School Psychology Review, 32*(3), 303–319.

Fisher, R., & Swindells, D. (1998). The development priorities of Ethiopian higher education teachers. *Journal of In-Service Education, 24*(2), 307–315.

Fullan, M. (2007). *The new meaning of educational change*. New York: Teachers College Press.

Fullan, M. G. (1991). *The new meaning of educational change* (2nd ed.). New York: Teachers College Press.

Gakio, K. (2006). *African tertiary institutions connectivity survey*. Report commissioned by the International Development Research Centre of Canada. Retrieved from http://www.aau.org/renu/docs/ATICS2006.pdf on 20th September, 2009.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Goodson, P., Murphy-Smith, M., Evans, A., Meyer, B., & Gottlieb, N. H. (2001). Maintaining prevention in practice: Survival of PPIP in primary care settings. *American Journal of Preventive Medicine, 20*(3), 184–189.

Guskey, T. R. (2000). *Evaluating teacher professional development*. Thousand Oaks, CA: Corwin.

Hargreaves, A., & Fink, D. (2000). The three dimensions of reform. *Educational Leadership, 57*(7), 30–34.

Harvey, G., & Hurworth, R. (2006). Exploring programme sustainability: Identifying factors in two educational initiatives in Victoria. *Evaluation Journal of Australasia, 6*(1), 36–44.

Hatch, T. (2000). What does it take to break the mold? Rhetoric and reality in new American schools. *Teachers College Record, 102*(3), 561–589.
Hord, S. M., & Summers, W. A. (2008). *Leading professional learning communities: Voices from research and practice*. Thousand Oaks, CA: Corwin.
Hoven, K. (2000). *A study on the potential of information and communication technologies in university education in Tanzania. A case study of the University of Dar es Salaam* (Master of arts thesis). Nijmegen, The Netherlands: Radboud University.
Joint, N. (2003). Information literacy evaluation: Moving towards virtual learning environments. *Electronic Library, 21*(4), 322–334.
Joyce, B. R., & Showers, B. (2002). *Student achievement through staff development* (3rd ed.). Alexandria, VA: ASCD.
Leem, J., & Lim, B. (2007). The current status of e-learning and strategies to enhance educational competitiveness in Korean higher education. *International Review of Research in Open and Distance Learning, 8*(1), 1–18.
Legters, N. E., Balfanz, R., Jordan, W. J., & McPartland, J. M. (2002). *Comprehensive reform for urban high schools: A talent development approach*. New York: Teachers College Press.
Lim, C. P., & Khine, M. S. (2006). Managing teachers' barriers to ICT integration in Singapore schools. *Journal of Technology and Teacher Education, 14*(1), 97–125.
Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91*(4), 509–536.
Ludwig-Hardman, S., & Dunlap, J. C. (2003). Learner support services for online students: Scaffolding for success. *International Review of Research in Open and Distance Learning, 4*(1), 1–15.
McLaughlin, M. W., & Mitra, D. (2001). Theory-based change and change-based theory: Going deeper and going broader. *Journal of Educational Change, 2*(4), 301–323.
Means, B., & Penuel, W. R. (2005). Scaling up technology-based educational innovations. In C. Dede, J. Honan, & L. Peters (Eds.), *Scaling up success: Lessons learned from technology-based educational innovation*. New York: Jossey-Bass.
Osganian, S. K., Parcel, G. S., & Stone, E. J. (2003). Institutionalization of a school health promotion programme: Background and rationale of the CATCHON study. *Health Education & Behavior, 30*(4), 410–417.
Paine-Andrews, A., Fisher, J. L., Campuzano, M. K., Fawcett, S. B., & Berkley-Patton, J. (2000). Promoting sustainability of community health initiatives: An empirical case study. *Health Promotion Practice, 1*(3), 248–258.
Pena-Bandalaria, M. D. (2007). Impact of ICTs on open and distance learning in a developing country setting: The Philippine experience. *International Review of Research in Open and Distance Learning, 8*(1), 1–15.
Richards, J. C., & Farrell, T. S. (2005). *Professional development for language teachers: Strategies for teacher learning*. New York: Cambridge University Press.
Sherry, L., & Gibson, D. (2002). The path to teacher leadership in educational technology. *Contemporary Issues in Technology and Teacher Education [Online serial], 2*(2), 178–203.
Sife, A. S., Lwoga, E. T., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *International Journal of Education and Development using Information and Communication Technology, 3*(20), 57–67.
Siritongthaworn, S., Krairit, D., Dimmitt, N. J., & Paul, H. (2006). The study of e-learning technology implementation: A preliminary investigation of universities in Thailand. *Education and Information Technologies, 11*(2), 137–160.
Steyn, G. M. (2005). Exploring factors that influence the effective implementation of professional development programs on invitational education. *Journal of Invitational Theory and Practice, 2*, 7–34.
Stoll, l., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*(4), 221–258.

Stoltenkamp, J., Kles, C., & Njenga, J. (2007). Institutionalizing the e-learning division at the University of the Western Cape, South Africa. *International Journal of Education and Development using Information and Communication Technology, 3*(4), 143–152.

Stringfield, S., & Datnow, A. (1998). Introduction: Scaling up school restructuring designs in urban schools. *Education and Urban Society, 30*(3), 269–276.

Ten Brummelhuis, A. C. A. (1995). *Models of educational change: The introduction of computers in Dutch secondary education*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Thijs, A., & Van den Berg, E. (2002). Peer coaching as part of a professional development program for science teachers in Botswana. *International Journal of Educational Development, 22*, 55–68.

Todorova, A., & Osburg, T. (2009). *Factors for the sustainability of a teacher professional development programme for technology integration*. Paper presented at the London International Conference on Education.

Voogt, J., Pieters, J., & Handelzalts, A. (2016). Teacher collaboration in curriculum design teams: Effects, mechanisms and conditions. *Educational Research and Evaluation, 22*(3–4), 121–140.

Walker, G., & Johnson, N. (2008). Faculty intentions to use components for web-enhanced instruction. *International Journal on E-Learning, 7*(1), 133–152.

Wiske, M. S., & Perkins, D. (2005). Dewey goes digital: Scaling up constructivist pedagogies and the promise of new technologies. In C. Dede, J. Honan, & L. Peters (Eds.), *Scaling up success: Lessons learned from technology-based educational innovation*. New York: Jossey-Bass.

Chapter 19
The Need for Curriculum Leadership to Sustain Systematic and Collaborative Curriculum Design Practices

Nabeel Albashiry

Introduction

TVET Curriculum Development in Developing Countries

In response to a growing demand for qualified middle-level professionals by businesses and industry, developing countries are paying an increasing attention to Technical Vocational Education and Training (TVET). This type of education is believed to reduce poverty and support economic growth by feeding the job market with qualified professionals and entrepreneurs who can make a living independently (Bureau of the Conference of Ministers of Education of the African Union, 2007; Killian, Tendayi, & Augustine, 2009; Ziderman, 1997). This continued interest in TVET is shown in the establishment of ministries for this particular type of education (e.g., in Yemen), the upgrading of polytechnics to a tertiary status (e.g., in Ghana), the expansion of TVET institutions (e.g., in Ethiopia, Yemen, and Tunisia), and the development of national policies and strategies for TVET, usually in collaboration with the World Bank or some donor countries (Bakah, Voogt, & Pieters, 2012a; Bureau of the Conference of Ministers of Education of the African Union, 2007; European Training Foundation & World Bank, 2004; Shumaker, 2013).

However, a growing body of research indicates a gap between the educational programs offered by TVET institutions in developing countries and the needs of the labor market, which therefore hampers the realisation of the stated intentions of this form of education (e.g., Agrawal, 2012; Baqadir, Patrick, & Burns, 2011). The TVET curriculum is usually of low quality, supply-driven, and incapable of keeping pace with the technological advances and socioeconomic changes to which the community and industry must respond (European Training Foundation & World

N. Albashiry (✉)
University of Auckland Business School, Auckland, New Zealand
e-mail: n.albashiry@auckland.ac.nz

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_19

Bank, 2004; Lai & Lo, 2008; Ziderman, 1997). Employers expect TVET educational programs not only to equip students with adequate entry-level vocational knowledge but also to provide them with a broad array of generic and entrepreneurial skills that render their graduates adaptable to work environments, able to learn new things in the workplace, aware of work ethics, and capable of working independently (Baqadir et al., 2011; Boateng, 2012; Lai & Lo, 2008). This requires TVET curricula to be broad in their goals and content (Finch & Crunkilton, 1999).

This vocational gap stems from various challenges that TVET institutions in developing countries encounter when striving to maintain the consistency of their programs with the stakeholders' needs. One setback lies in the reported inadequate collaboration between industry and TVET institutions on curriculum development matters, causing an expectation gap between these two parties (Akomaning, Voogt, & Pieters, 2011; Bakah, Voogt, & Pieters, 2012b). Other challenges include the lack of resources needed to have and maintain educational infrastructure (e.g., labs and workshops for practical training) and the absence of information and national statistics about the graduates' employment, which is necessary input for valid TVET curriculum updating (Lumby, 2000).

However, a major challenge receiving an increasing attention in both literature and practice concerns the low capacity of the academic management of TVET institutions for leading curriculum renewal projects that align TVET programs with the needs of concerned stakeholders (Gervedink Nijhuis, Voogt, & Pieters, 2012). Academic managers such as Heads of Department (HoDs) lack adequate competency to conduct systematic program renewals, due to scarce in-service professional development opportunities and inadequate attachment to industry, resulting in academic departments without goals and curricula that have not been reviewed for many years (Bakah et al., 2012a; Gervedink Nijhuis et al., 2012). This is an expected consequence, given that academic managers, especially in developing countries, are usually promoted to these leading positions based on their teaching seniority without going through adequate professional preparation, and assuming that good teachers can be good leaders (Mattar, 2012; Yielder & Codling, 2004).

Research Problem

As established above, TVET institutions in developing countries are expected to develop and maintain high quality and relevant educational programs, thereby contributing to the national development plans for poverty alleviation and economic growth. Unfortunately, a major challenge hampering the realisation of this goal lies in the low professional capacity of these institutions. Overestimating the capacity of the academic managers and teachers in TVET institutions to lead systematic curriculum development, given the lack of professional preparation for such an essential function, holds little promise for achieving the mandate of these institutions. The purpose of this educational design research was dual. From a design (problem-solving) perspective, it aimed first to professionally support HoDs to practice effective curriculum leadership when leading departmental curriculum work and second to promote teacher collaborative curriculum design, as both strategies hold great potential for realising sustainable and enhanced curriculum design practices. And from a scientific perspective, the study sought to describe the design and the impact of these two strategies along with identifying contextual constraints that might diminish their potential. This study moves research in this particular field and context beyond identifying gaps in the TVET curriculum and towards describing potential strategies for improving its quality and relevance.

Study Context

Sana'a Community College (SCC), the context of this study, is a leading TVET institution in Yemen. Community colleges in Yemen started as a new post-secondary educational structure having the purpose of bridging the vocational gap between the outcomes of regular universities and the fast-changing needs of the community and labour market (Alzubairy, 2009). Starting from one community college in the capital city in the academic year 2000–2001, there are now ten public community colleges in the country. These colleges serve a common mission of developing a middle-level skilled workforce to address the need for a stronger link between post-secondary education and employment in the corporate and industrial sectors (Shumaker, 2013).

Like most other TVET institutions, community colleges do not yet have accreditation standards to use as a benchmark for evaluating and updating their educational programs, nor do they have (active) quality assurance or curriculum development units in their premises. Therefore, academic departments in these institutions handle curriculum development activities based on their personal judgment and within their expertise.

Early batches of graduates from these colleges were generally well-received by industry and businesses; however, employers demanded new courses to be added, more attention to employability skills (e.g., English and computer skills), and more focus on the provision of hands-on learning experiences to students (Alzubairy, 2009).

Conceptual Framework

Curriculum and Curriculum Design

The concept of 'curriculum' in this chapter is used broadly to refer to the academic plans or blueprints that an educational institution has for guiding student learning (Lattuca & Stark, 2009; Taba, 1962; Wiles, 2009). These plans need to be comprehensive in order to attend to various aspects of the teaching-learning process, thereby minimising potential problems during the implementation of these plans. The 'curriculum' is usually manifested in three major representations (Goodlad, Klein, & Tye, 1979): the planned/formal curriculum (the educational intentions as described in curricular documents such as program/course descriptions), the enacted curriculum (i.e., curriculum in action), and the attained curriculum (the resulting student learning).

Curriculum design or curriculum development (used interchangeably in this chapter) can be defined as a lengthy and iterative process of planning, designing, implementing, and evaluating the student learning experiences in order to realise desired changes (Print, 1993; Van den Akker, 2003; Wiles, 2009). From a technical-professional perspective (Goodlad, 1994), that is, the technical aspects of the development process, the curriculum design process has been depicted in many various approaches and models. These are synthesised into four major paradigms (Visscher-Voerman & Gustafson, 2004): the instrumental paradigm, the communicative paradigm, the pragmatic paradigm, and the artistic paradigm. The first two of these paradigms seem to be relevant to the design of the TVET curriculum.

The first of these two paradigms is based upon a systematic (instrumental) approach, which dates back to Tyler's (1949) rational-linear approach. Most available systematic design models are variants of Tyler's approach. In the systematic approach, the development of the curriculum's learning outcomes is the focal point that determines the other components of the curriculum, such as the content, the learning strategies, and the assessment methods (Visscher-Voerman, Gustafson, & Plomp, 1999). This approach often revolves around an iterative cycle of five phases: analysis, design, development, implementation, and evaluation (Piskurich, 2006). The second paradigm represents a relational (communicative) approach that *explicitly* recognises the social context of the design. Design models within this paradigm are mostly influenced by Walker's (1990) deliberative approach. A key activity in the communicative approach is the extensive collaboration and deliberation between the curriculum developers and the stakeholders (e.g., employers, teachers, and institution management) throughout the design process to reach consensus about what the curriculum should be like (e.g., program structure, content, and pedagogy) and how it should be developed and implemented (Kessels & Plomp, 1999).

Kessels (1999) advocated, in a corporate education context, the simultaneous use of these two curriculum design approaches. He explained that the successful application of the systematic approach results in a well-organised curriculum with robust 'internal consistency', defined as coherence between the curriculum components, whereas the adoption of the relational (communicative) approach enhances the curriculum 'external consistency', defined as harmony in the perceptions of the stakeholders about what the curriculum's outcomes are and how they can be realised. Blending curriculum design approaches to address the particular context for which the curriculum is designed is becoming a popular trend (Van den Akker, 2003). Kessels' blend appears to hold great promise for the (re)development of the TVET curriculum.

Curriculum Leadership

With educational decentralisation gaining momentum, including in TVET, and the resulting shift in responsibilities and roles played by all stakeholders, there is increasing pressure on the academic managers of educational institutions to achieve better educational outcomes (Dinham, 2005; The European Centre for the Development of Vocational Training, 2011; Gajardo & Carmenado, 2012). Academic managers are increasingly expected to move beyond the traditional administrative role, attending more to their role as curriculum leaders: planning educational programs, maximising the learning experiences of students, and attending to external and internal curricular influences (Darling-Hammond, Meyerson, LaPointe, & Orr, 2009; Dinham, 2005; Fullan, 2007; Lattuca & Stark, 2009; Neumerski, 2012). Curriculum leadership can be defined as "a facilitating process in which the leader works with others to find common purpose, build collaborative teams, structure a way of working, and coordinate many complex activities" (Wiles, 2009, p. 21). Wiles (2009) further argued that "curriculum development is the essential function of school leadership. Whether this role is carried out by a principal, . . . a department head, . . . the curriculum defines all other roles in a school" (p. 2).

Achieving outstanding educational outcomes depends a great deal on the leadership of academic managers, with curriculum development at the core (Dinham, 2005). Conceptualising the daily leadership activities of academic managers (school principals) as climate-related activities (e.g., creating a positive learning environment, promoting teacher learning, and reducing the non-instructional interruptions) and technological behavior (e.g., setting goals, coordinating curriculum planning and implementation, and evaluating student achievement), Mattar (2012) found that the principals of high-achieving schools performed better than those of low-achieving ones in both sets of functions. Another study found that academic departments judged by senior management to be involved in effective curriculum design practices had HoDs who performed curriculum leadership tasks such as sensing curriculum problems and opportunities, creating structures for teacher collaboration, and introducing proposals for curricular change (Stark, Griggs, & Rowland-Poplawski, 2002).

Realising the critical role academic managers can play in maintaining and advancing curricula, there is clear emphasis in the literature regarding providing continuing professional support for academic managers to assume effective curriculum leadership (Brown, Rutherford, & Boyle, 2000; Neumerski, 2012; Nguyen, 2012; Vieira da Motta & Bolan, 2008). Academic managers attending professional development programs are reported to be more capable, more confident, and more involved in effective practices than those who do not participate in such professional opportunities (Darling-Hammond et al., 2009). The lack of training opportunities and the inadequate support and encouragement, especially for middle managers (e.g., HoDs), can prevent these managers from performing effective curriculum leadership tasks in practice (Nguyen, 2012; Stark et al., 2002; Wolverton, Ackerman, & Holt, 2005).

Collaborative Curriculum Design

Having competent curriculum leaders without the involvement and collaboration of the department teachers on curriculum design matters would not probably yield effective curriculum design practices and outcomes. Teacher collaborative curriculum design (TCCD) is a widely recognised curriculum design strategy because of its reported significant contributions to the professional development of teachers in areas such as subject matter and systematic curriculum design skills (Bakah, 2011; Huizinga, Handelzalts, Nieveen, & Voogt, 2015; Voogt et al., 2011). This strategy can also improve the harmony between the formal and the enacted curriculum, enhance teachers' ownership of the curriculum, and promote teachers' curricular collaboration (Bakah, Voogt, & Pieters, 2012c; George & Lubben, 2002; Handelzalts, 2009; Nihuka & Voogt, 2012).

This substantial impact of TCCD on both curriculum development and teacher professional development can be attributed to three sound theoretical principles underpinning TCCD: "… the situatedness of activity, agency, and the cyclical nature of learning and change" (Voogt et al., 2015, p. 261). 'Situatedness' refers to the fact that the curricular problems that the teachers work on and, hence, learn from are authentic and site-based. 'Agency' concerns the teachers' ownership of and their individual and collective responsibility for the curricular change, as this originates from addressing their own curricular needs. The 'cyclic nature of learning and change' refers to the interaction of the learning process with the cyclical nature of design: identifying a problem, analysing it, developing a solution, and experimenting with the new solution.

In a TVET context, however, teacher collaboration needs to be extended to involve employers and industry representatives in order to establish the curriculum's external consistency. External consistency defined as harmony in the stakeholders' perceptions of what the curriculum's outcomes are and how they can be realised (Finch & Crunkilton, 1999; Kessels, 1999). Although the external consistency of the TVET curriculum in developing countries is often threatened by a lack of *formal* collaboration between TVET institutions and industry, studies conducted in such a context indicate that TCCD has great potential for improving this form of curriculum consistency. Akomaning (2012) investigated how TCCD that involved industry representatives improved the internship curriculum within Ghanaian polytechnics. He found that student internship practices had improved, and that all concerned stakeholders (teachers, polytechnics management, students, and industry) were satisfied with the newly structured internship curriculum, as the TCCD strategy provided a collaborative platform for those stakeholders to develop a shared vision and consensus about the new internship curriculum. Bakah (2011) also reported how TCCD that involved industrial site visits by teachers to see new trends and technology not only improved the learning and teaching practices of the participating teachers, but also had a positive impact on the relevance of the courses they collaboratively redesigned. These two studies, along with some others (e.g., Nihuka, 2011), suggest that TCCD is an efficient strategy that can simultaneously improve teacher learning and the curriculum aspect being (re-)designed.

Research Question

College academic departments are central units where the curriculum (i.e., plans for student learning) is commonly engineered and updated (Hecht, 2004; Nguyen, 2012). The professional capacity of academic departments (i.e., HoDs and teachers) in TVET institutions therefore needs to be improved so that these institutions can maintain and enhance the internal and external consistency of their curricula. The overall research question of this study was: *How can professional development support help TVET college middle managers and teachers improve their curriculum design practices with regard to enhanced curriculum consistency?*

Research Design

Case Study Approach

A case study approach was used as the specific methodology for this study. This approach is preferred when a study seeks to explain 'how' and 'why' a contemporary phenomenon functions in a certain way in a real-life setting with little control over the events (Yin, 2003). In line with Yin's reasoning, this study did not aim for 'statistical generalisation'; it rather endeavored to contribute to the theoretical understanding (analytical generalisation) of the phenomenon under study (professional development support for TVET HoDs and teachers) as undertaken by a specific group of people in a specific context. Another reason for using a case study approach is the flexibility it affords in using multiple methods of data collection and, hence, multiple ways of building up evidence (Schell, 1992).

Within the case study approach, this study used a mixed-method design for the four studies, based on the purpose and scope of each one. Each study employed several data collection methods to achieve data triangulation in order to improve the validity of conclusions (Yin, 2003). Validity and reliability of instruments were considered through, for example, the calculations of reliability coefficients (Cronbach's alpha and Cohen's kappa) of the study questionnaires and interviews. Qualitative data were collected through semi-structured interviews, observations, curricular documents, and field notes. Analysis of qualitative data was conducted systematically through employing both inductive and deductive procedures (Miles & Huberman, 1994; Thomas, 2006) with the help of qualitative data analysis software (Atlas.ti7). Quantitative data came mainly from the questionnaires administered, which used Likert and rating scales. Descriptive and inferential statistics were obtained through the use of SPSS statistical software.

Main Findings

The findings from a previous explanatory study (Albashiry, Voogt, & Pieters, 2015a) showed that there was a major problem with the college's formal curriculum (curriculum design as a blueprint). Learning outcomes, program/course descriptions, and internal curriculum policies regulating curriculum design activities were either missing or ill-defined. Curriculum design as a process was found to be mostly ad hoc, intuitive, individual, and centered around modifying individual courses, losing the global view of the whole academic program delivered by each department. Involvement of external stakeholders in programs' renewals following their inception was absent. The need for professional development on managing curriculum design activities was one issue clearly communicated by teachers, HoDs, and Heads of Divisions.

First Professional Development Arrangement (PDA-1)

The purpose of this sub-study (Albashiry, Voogt, & Pieters, 2015b) was to describe the design, relevance, and effects of the first professional development arrangement (PDA-1) for the college middle managers (HoDs and Heads of Division) as an initial intervention aimed at improving the curriculum design practices identified in the exploratory study. This sub-study addressed the overall question: *"What impact can a professional development arrangement have on improving the curriculum leadership of college middle managers?*". PDA-1 aimed first to improve the middle managers' learning about systematic and relational curriculum design and second to support them in developing curriculum design policies such that they could practice effective curriculum leadership while improving the current ad hoc curriculum design practices. The effects of PDA-1 were measured at the first three levels of Kirkpatrick's model (Kirkpatrick & Kirkpatrick, 2006): the participants' perceptions of PDA-1's relevance, their learning, and their post-intervention curriculum design practices.

The findings showed that the middle managers highly appreciated the design and the content of PDA-1 and found it relative and supportive to their work as curriculum leaders. The middle managers also gained substantial learning about systematic and collaborative curriculum design, which included a change in their perceptions about the concepts of 'curriculum' and 'curriculum design'. The middle managers' beliefs shifted towards a broader perspective of 'curriculum design' compared with their previous notions that had mostly confined such a process to the updating of the syllabi of individual courses by individual teachers. Improved confidence in leading systematic and collaborative curriculum design activities was also reported. However, at the third level (applying the new learning and the developed curriculum policies), the middle managers' post-PDA-1 curriculum design efforts were minimal and characterised by individual initiatives, due to several challenges. These included the lack of top management support, unfavorable work conditions, a high rate of middle manager attrition, and the inadequate curriculum design expertise of department teachers. It was also clear that HoDs needed more professional development support on leading curriculum design projects.

Second Professional Development Arrangement (PDA-2)

This sub-study (Albashiry, Voogt, & Pieters, 2016) reported on the second round of the professional development arrangement (PDA-2). PDA-2 comprised further training for HoDs (focusing this time on curriculum leadership tasks) and initial training for teachers (focusing on basics of curriculum design), followed by a curriculum development project led by HoDs. The curriculum development project aimed to give the HoDs and the teachers the opportunity to practice and demonstrate the desired curriculum design and curriculum leadership practices and at the same time to improve the internal and external consistency of their formal curricula.

Conceptualising curriculum leadership as four major tasks, this sub-study focused on how the participating HoDs perceived and enacted these tasks after receiving relevant training and assistance (e.g., coaching, handouts, templates, and exemplary materials). The study also captured HoDs' perceptions about the support they received and the challenges they encountered while leading the curriculum development project. The overall question for this study was: *"How do middle managers perceive and enact curriculum leadership tasks within curriculum development projects?"*

The findings showed that the HoDs valued the relevance and the usefulness of the multiple forms of support received and the curriculum leadership experience, which made them realise the significance of their role as curriculum leaders compared with the traditional administrative role that had been their major focus. The findings also indicated that the ways the HoDs enacted the curriculum leadership tasks and the challenges they encountered varied based on several factors including the HoD's commitment, management and leadership skills, knowledge about curriculum design, and the department context.

Teacher Collaborative Curriculum Design

During PDA-2, four academic departments worked on re-designing their programs of study. Under the leadership of the HoD, a team of teachers from each department worked collaboratively to re-design their academic programs systematically and relationally in order to improve the internal and external consistency of the curriculum. A sub-study (Albashiry, Voogt, & Pieters, 2015c) explored how the four teacher collaborative curriculum design (TCCD) teams went about this undertaking, capturing the participants' perceptions of the TCCD process and its outcomes. All the design teams except for one team (due to departmental problems) managed to redesign their academic programs systematically and relationally, with varying degrees of success.

Applying a systematic approach, these teams followed a systematic design cycle (analysis, design, development, and evaluation) to develop the formal curriculum of their departments. The teams linked the department mission with the department goals and the program's learning outcomes with the courses' learning outcomes (internal consistency). Given the novelty of this approach, working systematically was a time- and effort-demanding process for all teams. Among the challenges encountered in applying this approach were the phrasing of the program's and courses' learning outcomes, developing data collection instruments, analysing the data collected, and conducting formative evaluation. This required providing coaching and just-in-time support during the design process.

However, applying a relational approach was more challenging in terms of feasibility. Only one team could involve concerned stakeholders as co-designers while the other teams just managed to involve their curriculum stakeholders just as informants. Involving external stakeholders (e.g., subject matter experts and industry representatives) was also found to be harder than involving the internal ones (e.g., department teachers and students). This difficulty of establishing external consistency seemed to be a natural consequence of the lack of formal coordination between TVET institutions and industry and of the absence of a professional network in the college for curriculum review purposes.

Despite these challenges in applying systematic and relational procedures, the teachers felt positive about the TCCD experience and its outcomes. The teams perceived their formal curricula now to have better clarity and consistency because of their application of systematic and relational design procedures. The teachers also reported that this undertaking helped them learn new skills and develop a sense of clarity together with a holistic view of the department curriculum, and fostered their collaboration and commitment to the department curriculum.

Conclusion

The research reported in this chapter was based on the premise that in-service professional development of HoDs and teachers that is geared towards HoDs' curriculum leadership and teacher collaborative curriculum design (TCCD) holds great promise for the professionalisation of curriculum design practices in TVET academic departments, which can eventually lead to sustainable curriculum consistency. This educational design study aimed to improve the status quo regarding the educational problem at hand, and at the same time to produce theoretical understanding of how the intervention played out in a real-world setting.

The findings of the studies showed that professionally-supported middle managers and teachers demonstrated improved curriculum design and leadership practices that contributed to the improvement of the curriculum internal and external consistency. The programs redesigned in this study had better clarity, greater detail, and improved connectedness between various components such as department goals, program's learning outcomes, and courses' learning outcomes (internal consistency). In addition, the resulting curricular artefacts (e.g., new/modified courses, updated content, and program's learning outcomes) were perceived by teachers and HoDs to be relevant to the needs and expectations of industry and prospective employers. Similar positive outcomes concerning curriculum consistency have been reported in similar TVET contexts as a result of professionally- supported teachers' curriculum design efforts (Akomaning et al., 2011; Bakah et al., 2012b).

The reported improved curriculum design practices and curriculum consistency in this study can be attributed to several factors. First, the multiple forms of professional development support that the teachers and HoDs received (e.g., training, coaching, exemplary materials, handouts, and templates) played a significant role in these stakeholders' learning about and application of systematic and relational curriculum design practices (cf. Darling-Hammond et al., 2009). Second, the professional development support in its two rounds took into account contextual constraints by incorporating a decrease in workload for participants, providing incentives, and flexibility in scheduling training sessions and other activities (Bakah et al., 2012b; Guskey, 2000, 2003). This created an overall positive work environment for the HoDs and teachers and hence effected a positive attitude towards the curriculum design undertaking. It also helped alleviate the tension between the participants' commitment to their routine academic work and the curriculum project. Further, the application of a systematic and relational approach was a major contributor to the reported improved internal and external consistency of curricula (Kessels, 1999; Kessels & Plomp, 1999). Moreover, the relatively extended time span of the intervention (Guskey, 2000, 2003) and the piecemeal evolution of the project activities probably helped the teachers and HoDs cope with the novelty and complexity of the curriculum design approach used during the program re-design task.

The findings also indicate that although professionally supported HoDs and teachers at TVET institutions further realise the importance of involving external stakeholders to enhance curriculum external consistency, accomplishing this task is not always feasible in practice. The lack of formal professional networking and liaisons with industry in many developing countries represents a great challenge for TCCD teams to reach and involve prospective employers and industry representatives in the (re)-design of their educational programs (Akomaning et al., 2011).

Further, it may be concluded that in-service professional development support for HoDs with a focus on curriculum leadership has a positive impact, to varying degrees, on HoDs' learning and ability to lead effective curriculum design practices. Professional development support with such a focus also renders HoDs more appreciative of and alert to their role as curriculum leaders and more aware of how such a role extends beyond the administrative domain (Aziz et al., 2005). The findings suggest that HoDs still need further *tailored* professional support in three professional competencies (curriculum design, management, and leadership) so as to match the individual professional development needs of HoDs. The findings indicate, however, that besides the provision of adequate professional support, HoDs critically need positive work conditions and organisational support (e.g., senior managers' follow-up, clarity of curriculum development expectations for teachers, middle management, and senior management, and provision of incentives for curriculum work) to exercise effective curriculum leadership in practice (cf. Kirkpatrick & Kirkpatrick, 2006).

Reflections and Implications

Challenges Associated with the Position of HoD

The position of HoD in TVET institutions in developing countries does not seem to be either financially or professionally rewarding enough for department teachers to accept or opt for (Gervedink Nijhuis et al., 2012). In such a context, HoDs are often consumed by many administrative tasks such as coordinating student exams, reporting grades, following up on teachers' performance, solving students' problems, and improvising solutions for urgent issues. Little energy and peace of mind are left for HoDs to turn to curriculum development matters (cf. Marsh & Willis, 1999). Furthermore, in-service training for HoDs, especially on effective curriculum design approaches, is seriously inadequate.

Such work conditions for HoDs result in a high attrition rate in this academic position and make this critical leadership position tend to be occupied by less qualified teachers (Akomaning, 2012; Gervedink Nijhuis et al., 2012). This is why the intervention in this study took into consideration the establishment of a supportive climate for the participating HoDs to work on a major curriculum renewal. The training provided and the incentive package offered (e.g., a workload decrease and monetary incentives) were highly appreciated by the participating HoDs. This clearly implies that if HoDs are to lead tangible and sustainable curriculum development efforts towards better curriculum consistency, both professional and organisational support need to be provided by senior management.

Competencies for Curriculum Leaders

In congruence with the literature on academic leadership (e.g., Glatthorn, Boschee, Whitehead, & Boschee, 2012; Marlow & Minehira, 1996; Sorenson, Goldsmith, Mendez, & Maxwell, 2011; Stark et al., 2002; Wiles, 2009), reflections on how the professional support for HoDs in this study played out in practice suggest that for HoDs of TVET institutions to demonstrate effective curriculum leadership, they need to possess three professional competencies: curriculum design, management, and leadership. These three competencies refer to knowledge, skills, and attitudes needed by HoDs to lead sustainable curriculum design practices.

Curriculum design competency is needed to handle the technical curriculum development tasks and activities such as conducting a needs analysis, annual program reviews, course evaluations, and curriculum mapping. Management competency is needed by HoDs to conduct the several administrative tasks necessary to facilitate the various curriculum development activities. These tasks include, for example, developing curriculum work structures and action plans, assigning curriculum design tasks, and locating/allocating resources for the curriculum work. Leadership competency includes tasks such as motivating teachers to participate in curriculum development activities, establishing a shared vision, resolving conflicts, and promoting collaboration. The leadership tasks are highly contextual, more proactive, and more personal than the managerial tasks (Fidler, 1997).

Teacher Collaborative Curriculum Design

In this study, despite the novelty and difficulty for the TCCD teams to apply a systematic and relational approach, these teams achieved tangible outcomes that positively contributed to the internal and external consistency of their curricula, as perceived by the TCCD teams. This suggests that *professionally-supported* TCCD teams can function as an institution-based curriculum development strategy for ongoing curriculum renewals at TVET institutions in developing countries. It seems to be a timely and financially appropriate solution for the reportedly stagnant curriculum development activities at these institutions, as it would require less spending on external curriculum development support.

While the TCCD teams in this study managed, to some degree, to conduct activities associated with internal and external curriculum consistency, they encountered several challenges that the senior managers of TVET institutions and probably higher government bodies would need to address. For internal consistency, the TCCD teams were missing a national or regional accreditation framework with which to align elements such as program's learning outcomes and program/course credit hours. Moreover, the teams still need ongoing professional support so as to establish coherence between the curriculum components (e.g., goals, content, instructional approaches, and assessment) and between the curriculum representations (e.g., the planned, enacted, and attained curriculum). For external consistency, organisational support appears to be more critical for TCCD teams in TVET institutions. Although it was difficult for the TCCD teams in this study to approach businesses and industry (without prior official coordination by the institution) and to involve them as co-designers of their educational programs, the study suggests that once stakeholders are involved, they are positively inclined to participate.

Threats to Sustainable Curriculum Leadership and TCCD

The intervention in this study succeeded in achieving its short-term goals of both professional development and curriculum development outcomes. The intervention helped the teachers and HoDs learn about curriculum design and curriculum leadership, develop curriculum policies, and improve the clarity, detail, and consistency of their formal curricula. Although assessing the achievement of the intervention's long-term goals (i.e., adopting a systematic and relational approach to curriculum design and maintaining effective curriculum leadership and TCCD practices by academic departments) was beyond the scope of this study, the findings of this study reveal some positive indicators. These include the HoDs' and teachers' buy-in to the curriculum design approach and to the strategies of curriculum leadership and TCCD, and their intention to complete the remaining parts of the curriculum renewal project. However, the achievement of the intervention's long-term goals is quite likely to be hampered by a number of threats.

One threat concerns the inadequate organisational support that teachers and HoDs receive from senior management in forms such as encouragement, follow-up on their curriculum work, and monetary incentives (Ottevanger, Van de Grint, & Ana'am, 2010). The findings also suggest an expectation gap between the middle and senior management regarding curriculum development responsibilities and the support needed. Personal communication with the senior managers revealed that the college's budgetary constraints and their busy administrative agendas hindered them from providing the support needed by HoDs and teachers. It seems quite critical that the senior management of TVET institutions hold regular meetings with HoDs and teachers to ensure that curriculum development expectations are collectively developed and shared (Wiles, 2009).

Another threat to the sustainability of curriculum leadership and TCCD lies in the high rate of teacher and HoD attrition and mobility in such contexts, due to unsupportive work conditions and the constant search of these critical curriculum stakeholders for better job offers from industry or private educational institutions (Akomaning, 2012; Gervedink Nijhuis et al., 2012). Both the government and the senior management of the TVET institutions need to make sure that HoDs and teachers are adequately supported in meeting the expectations to maintain the quality and relevance of the vocational curriculum. Sustainable curriculum development requires a stable work environment and a high level of ownership by senior management (Akomaning, 2012; Ottevanger et al., 2010).

References

Agrawal, T. (2012). Vocational education and training in India: Challenges, status and labor market outcomes. *Journal of Vocational Education & Training, 64*(4), 453–474. https://doi.org/10.1080/13636820.2012.727851

Akomaning, E. (2012). *Improving student internship through collaborative curriculum design in Ghanaian polytechnics*. Doctoral dissertation. Enschede, The Netherlands: University of Twente. https://doi.org/10.3990/1.9789036533188.

Akomaning, E., Voogt, J. M., & Pieters, J. M. (2011). Internship in vocational education and training: Stakeholders' perceptions of its organization. *Journal of Vocational Education and Training, 63*(4), 575–592. https://doi.org/10.1080/13636820.2011.590222

Albashiry, N., Voogt, J. M., & Pieters, J. M. (2015a). Curriculum design practices of a vocational community college in a developing context: Challenges and needs. *Community College Journal of Research and Practice, 39*(12), 1137–1152. https://doi.org/10.1080/10668926.2014.942894

Albashiry, N., Voogt, J. M., & Pieters, J. M. (2015b). Improving curriculum development practices in a technical vocational community college: Examining effects of a professional development arrangement for middle managers. *The Curriculum Journal, 26*(13), 425–451. https://doi.org/10.1080/09585176.2015.1040041

Albashiry, N., Voogt, J. M., & Pieters, J. M. (2015c). Teacher collaborative curriculum design in technical vocational colleges: A strategy for maintaining curriculum consistency? *The Curriculum Journal, 26*(3), 601–624. https://doi.org/10.1080/09585176.2015.1058281

Albashiry, N., Voogt, J. M., & Pieters, J. M. (2016). Curriculum leadership in action: A tale of four community college heads of department leading a curriculum development project. *Community College Journal of Research and Practice, 40*(5), 401–413. https://doi.org/10.1080/10668926.2015.1065775

Alzubairy, I. (2009). مدى مواءمة التخصصات التقنية في كليات المجتمع مع متطلبات سوق العمل اليمني: كلية المجتمع صنعاء حالة تطبيقية - [Extent of alignment of technical majors at SCC with the Yemeni labor market needs] Unpublished Master's thesis. Sana'a, Yemen: Sana'a University.

Aziz, S., Mullins, M., Balzer, W., Grauer, E., Burnfield, J., Lodato, M., et al. (2005). Understanding the training needs of departmental chairs. *Studies in Higher Education, 30*(5), 571–593. https://doi.org/10.1080/03075070500249260

Bakah, M. A. (2011). *Teacher professional development through collaborative curriculum design in Ghana's polytechnics*. Doctoral dissertation. Enschede, The Netherlands: University of Twente. https://doi.org/10.3990/1.9789036532396.

Bakah, M. A., Voogt, J. M., & Pieters, J. M. (2012a). Curriculum reform and teachers' training needs: The case of higher education in Ghana. *International Journal of Training and Development, 16*(1), 67–76. https://doi.org/10.1111/j.1468-2419.2011.00389.x

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012b). Updating polytechnic teachers' knowledge and skills through teacher design teams in Ghana. *Professional Development in Education, 38*(1), 7–24. https://doi.org/10.1080/19415257.2011.576265

Bakah, M. A. B., Voogt, J. M., & Pieters, J. M. (2012c). Advancing perspectives of sustainability and large-scale implementation of design teams in Ghana's polytechnics: Issues and opportunities. *International Journal of Educational Development, 32*, 787–796. https://doi.org/10.1016/j.ijedudev.2011.11.002

Baqadir, A., Patrick, F., & Burns, G. (2011). Addressing the skills gap in Saudi Arabia: Does vocational education address the needs of private sector employers? *Journal of Vocational Education & Training, 63*(4), 551–561. https://doi.org/10.1080/13636820.2011.589533

Boateng, C. (2012). Evolving conceptualizations of leadership and its implications for vocational technical education. *World Journal of Education, 2*(4), 45–54. https://doi.org/10.5430/wje.v2n4p45

Brown, M., Rutherford, D., & Boyle, B. (2000). Leadership for school improvement: The role of the head of department in UK secondary *schools*. *School Effectiveness and School Improvement, 11*, 237–258. https://doi.org/10.1076/0924-3453(200006)11:2;1-Q;FT237

Bureau of the Conference of Ministers of Education of the African Union. (2007). *Strategy to revitalize technical and vocational education and training (TVETT) in Africa (Addis Ababa)*. Retrieved from http://info.worldbank.org/etools/docs/library/243614/TVETT%20Strategy%20in% 20Africa. pdf.

Darling-Hammond, L., Meyerson, D., LaPointe, M., & Orr, M. (2009). *Preparing principals for a changing world: Lessons from effective school leadership programs*. San Francisco: Jossey-Bass.

Dinham, S. (2005). Principal leadership for outstanding educational outcomes. *Journal for Educational Administration, 43*(40), 338–356. https://doi.org/10.1108/09578230510605405

European Training Foundation & World Bank. (2004). *Technical education and vocational training in Yemen and its relevance to the labour market*. Retrieved from http://www.etf.europa.eu/web.nsf/(RSS)/C125782B0048D6F6C125700700289D14?OpenDocument&LAN=EN

Fidler, B. (1997). School leadership: Some key ideas. *School Leadership and Management, 17*(1), 23–37. https://doi.org/10.1080/13632439770140

Finch, C. R., & Crunkilton, J. R. (1999). *Curriculum development in vocational and technical education: Planning, content, and implementation* (5th ed.). Boston: Allyn and Bacon.

Fullan, M. G. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Gajardo, F., & Carmenado, I. (2012). Professional certification for school principals: Approach of a competence based profile for education quality improvement. *Procedia – Social and Behavioral Sciences, 46*, 917–925. https://doi.org/10.1016/j.sbspro.2012.05.224

George, J. M., & Lubben, F. (2002). Facilitating teachers' professional growth through their involvement in creating context-based materials in science. *International Journal of Educational Development, 22*(6), 659–672. https://doi.org/10.1016/S0738-0593(01)00033-5

Gervedink Nijhuis, C. J., Voogt, J. M., & Pieters, J. M. (2012). The cultural complexity of international collaboration: Conditions for sustainable curriculum development in Ghana. *International Journal of Intercultural Relations, 36*, 647–658. https://doi.org/10.1016/j.ijintrel.2012.02.003

Glatthorn, A., Boschee, F., Whitehead, B., & Boschee, B. (2012). *Curriculum leadership* (3rd ed.). Los Angeles: Sage.

Goodlad, J. (1994). Curriculum as a field of study. In T. Husén & T. Postlethwaite (Eds.), *The international encyclopedia of education* (pp. 1262–1276). Oxford, UK: Pergamon Press.

Goodlad, J. I., Klein, F., & Tye, K. A. (1979). The domains of curriculum and their study. In J. I. Goodlad et al. (Eds.), *Curriculum inquiry: The study of curriculum practice* (pp. 43–76). New York: McGraw Hill.

Guskey, T. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press, Inc.

Guskey, T. R. (2003). What makes professional development effective? *Phi Delta Kappan, 84*(10), 748–750. https://doi.org/10.1177/003172170308401007

Handelzalts, A. (2009). *Collaborative curriculum development in teacher design teams*. Doctoral dissertation. Enschede, The Netherlands: University of Twente. https://doi.org/10.3990/1.9789036528634.

Hecht, I. W. D. (2004). The professional development of division chairs. *New Directions for Higher Education, 126*, 27–44. https://doi.org/10.1002/he.146

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2015). Fostering teachers' design expertise in teacher design teams: Conducive design and support activities. *The Curriculum Journal, 26*(1), 137–163. https://doi.org/10.1080/09585176.2014.990395

Kessels, J., & Plomp, T. (1999). A systematic and relational approach to obtaining curriculum consistency in corporate education. *Journal of Curriculum Studies, 31*(6), 679–709. https://doi.org/10.1080/002202799182945

Kessels, J. W. M. (1999). A relational approach to curriculum design. In J. J. H. Van den Akker, R. Branch, K. Gustafson, N. Nieveen, & T. Plomp (Eds.), *Design and development methodology in education* (pp. 59–70). Dordrecht, Netherlands: Kluwer Academic Publishers.

Killian, M., Tendayi, G., & Augustine, T. (2009). An assessment of partnerships between technical vocational education and training and its stakeholders in the development of Ethiopian SMEs. *Economia, Seria Management, 12*(2), 39–56. Retrieved from https://ideas.repec.org/a/rom/econmn/v12y2009i2p39-56.html

Kirkpatrick, D. L., & Kirkpatrick, J. D. (2006). *Evaluating training programs: The four levels* (3rd ed.). San Francisco: Berrett-Koehler.

Lai, M., & Lo, L. N. (2008). Perceived workplace competences at three sites on the Chinese mainland. *Journal of Vocational Education & Training, 60*(2), 189–204. https://doi.org/10.1080/13636820802042461

Lattuca, L., & Stark, J. (2009). *Shaping the college curriculum: Academic plans in context*. San Francisco: Jossey-Bass.

Lumby, J. (2000). Technical colleges in South Africa: Planning for the future. *Journal of Vocational Education & Training, 52*(1), 101–118. https://doi.org/10.1080/13636820000200109
Marlow, S., & Minehira, N. (1996). *Principals as curriculum leaders: New perspectives for the 21st century*. Honolulu, HI: Pacific Resources for Education and Learning.
Marsh, C. J., & Willis, G. (1999). *Curriculum: Alternative approaches, ongoing issues* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.
Mattar, D. (2012). Instructional leadership in Lebanese public schools. *Educational Management, Administration and Leadership, 40*(4), 509–531. https://doi.org/10.1177/1741143212438222
Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage.
Neumerski, C. M. (2012). Rethinking instructional leadership, a review: What do we know about principal, teacher, and coach instructional leadership, and where should we go from here? *Educational Administration Quarterly, 49*(2), 310–347. https://doi.org/10.1177/0013161X12456700
Nguyen, H. T. (2012). Identifying the training needs of heads of department in a newly established university in Vietnam. *Journal of Higher Education Policy and Management, 34*(3), 309–321. https://doi.org/10.1080/1360080X.2012.678730
Nihuka, K. A. (2011). *Collaborative curriculum design to support implementation of e-learning by instructors*. Doctoral dissertation. Enschede, The Netherlands: University of Twente. https://doi.org/10.3990/1.9789036532358.
Nihuka, K. A., & Voogt, J. M. (2012). Collaborative e-learning course design: Impacts on instructors in the Open University of Tanzania. *Australasian Journal of Educational Technology, 28*(2), 232–248. Retrieved from http://www.ascilite.org.au/ajet/ajet28/nihuka.html
Ottevanger, W., Van de Grint, L., & Ana'am, M. (2010). The effectiveness of staff development at universities in Yemen. In M. Cantrell, R. Kool, & W. Kouwenhoven (Eds.), *Access and expansion: Challenges for higher education improvement in developing countries* (pp. 91–107). Amsterdam: VU University.
Piskurich, G. M. (2006). *Rapid instructional design: Learning ID fast and right*. San Francisco: Wiley.
Print, M. (1993). *Curriculum development and design*. Sydney, Australia: Allen and Unwin.
Schell, C. (1992). *The value of the case study as a research strategy*. Manchester Business School. Retrieved from http://www.finance-mba.com/Case%20Method.pdf
Shumaker, J. W. (2013). U.S. community colleges and a response to the Arab spring. In T. Treat & L. Hagedorn (Eds.), *The community college in a global context: New directions for community colleges* (pp. 113–128). San Francisco: Jossey-Bass.
Sorenson, R. D., Goldsmith, L. M., Mendez, Z., & Maxwell, K. (2011). *The principal's guide to curriculum leadership*. Thousand Oaks, CA: Corwin Press.
Stark, J. S., Griggs, C. L., & Rowland-Poplawski, J. (2002). Curriculum leadership roles of chairs in continuously planning departments. *Research in Higher Education, 43*(3), 329–357. https://doi.org/10.1023/A:1014841118080
Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt, Brace & World.
The European Centre for the Development of Vocational Training. (2011). *Vocational education and training at higher qualification levels (no. 15)*. Luxembourg: Publications Office of the European Union. Retrieved from http://www.cedefop.europa.eu/en/publications-and-resources/publications/5515
Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*, 237–246. https://doi.org/10.1177/1098214005283748
Tyler, R. (1949). *Basic principles of curriculum and instruction*. Chicago: The University of Chicago Press.
Van den Akker, J. J. H. (2003). Curriculum perspectives: An introduction. In J. J. H. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscape and trends* (pp. 1–10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Vieira da Motta, M., & Bolan, V. (2008). Academic and managerial skills of academic deans: A self-assessment perspective. *Tertiary Education and Management, 14*, 303–316. https://doi.org/10.1080/13583880802481740

Visscher-Voerman, I., & Gustafson, K. (2004). Paradigms in the theory and practice of education and training design. *Educational Technology Research & Development, 52*(2), 69–89. https://doi.org/10.1007/BF02504840

Visscher-Voerman, I., Gustafson, K., & Plomp, T. (1999). Educational design and development: An overview of paradigms. In J. J. H. Van den Akker, R. M. Branch, K. Gustafson, N. Nieveen, & T. Plomp (Eds.), *Design approaches and tools in education and training* (pp. 15–29). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science, 43*, 259–282. https://doi.org/10.1007/s11251-014-9340-7

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., Pieters, J., & De Vries, B. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235–1244. https://doi.org/10.1016/j.tate.2011.07.003

Walker, D. F. (1990). *Fundamentals of curriculum*. San Diego, CA: Harcourt Brace Jovanovich.

Wiles, J. (2009). *Leading curriculum development*. Thousand Oaks, CA: Corwin Press.

Wolverton, M., Ackerman, R., & Holt, S. (2005). Preparing for leadership: What academic department chairs need to know. *Journal of Higher Education Policy and Management, 27*(2), 227–238. https://doi.org/10.1080/13600800500120126

Yielder, J., & Codling, A. (2004). Management and leadership in the contemporary university. *Journal of Higher Education Policy and Management, 26*(3), 315–328. https://doi.org/10.1080/1360080042000290177

Yin, R. K. (2003). *Case study research, design and methods* (3rd ed.). Newbury Park, CA: Sage Publications.

Ziderman, A. (1997). National programs in technical and vocational education: Economic and education relationships. *Journal of Vocational Education & Training, 49*(3), 351–366. https://doi.org/10.1080/13636829700200026

Chapter 20
Continuation of Collaborative Curriculum Design Outcomes: Teachers' Transfer of Teaching with Technology

Douglas D. Agyei and Ayoub Kafyulilo

Introduction

The focus of most professional development projects is on the development of effects that will continue even some years after the project's termination (Harvey & Hurworth, 2006; Zehetmeier, 2009). Informing the stakeholders that an initiative has been designed well, or has been successful, is not enough, because quite often, after funding ends or staff leave, such programs can collapse (Harvey & Hurworth, 2006). According to these authors, the question should be: is this program continued after the professional development has finished? As a response to this question, the two studies reported in this chapter were conducted to investigate the extent to which pre-service and in-service teachers continued to use technology in their teaching after the professional development arrangement had ended. We consider the long-term effectiveness of professional development arrangements in terms of the continuation of technology integration practices that use the knowledge, skills and beliefs about technology integration in teaching that were acquired during the professional development projects. The outcomes of the two studies will be presented and discussed in this chapter.

The first study pertained to teachers' involvement in technology use in mathematics teaching in Ghana. Positive effects have been reported from incorporating technology in teaching mathematics to enhance motivation and improve student achievement (Agyei & Voogt, 2011a). However, many maths teachers do not feel

D. D. Agyei (✉)
Department of Mathematics and ICT Education, University of Cape Coast, Cape Coast, Ghana
e-mail: ddagyei@ucc.edu.gh

A. Kafyulilo
Department of Psychology and Curriculum Studies, Dar es Salaam University College of Education, Dar es Salaam, Tanzania
e-mail: vangidunda@yahoo.co.uk

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_20

proficient in teaching mathematics lessons that take advantage of technology-rich environments. Technology simply being present in the classroom is not enough, and the use of technology is a responsibility left ultimately to mathematics teachers. Integrating technology in teaching mathematics is a very complex and difficult task for mathematics teachers. They must learn to use new technologies appropriately and to incorporate them in lesson plans and lesson enactment. Professional development is therefore critical for helping pre-service teachers to develop the proper skill set and required knowledge before such instructional change can occur. In the first study, a professional development arrangement in which pre-service teachers collaboratively designed and used technology to teach for the first time was carried out. Technology is presented as a tool for enacting a guided activity-based pedagogical approach (referred to as Activity-Based Learning) to teaching mathematical concepts in order to develop pre-service teachers' knowledge and skills for teaching with technology. In the study, Technological Pedagogical Content Knowledge (TPACK) was used as a conceptual framework guiding the preparation of pre-service teachers for ICT integration (cf. Koehler & Mishra, 2005) because it seemed an interesting and useful framework for better understanding what knowledge base teachers need to incorporate ICT in their teaching. Although TPACK is often assessed on a more generic and abstract level that measures perceived knowledge that does not reflect specific content knowledge, specific pedagogical knowledge or specific technological knowledge, the study described in this chapter particularly focused on specific spreadsheet applications in enacting a guided activity-based pedagogical approach to develop pre-service teachers' TPACK for teaching mathematics.

The second study was based on three previous studies conducted in Tanzania that showed that participants in a professional development arrangement developed technology integration knowledge and skills, as was revealed through self-report data, lesson plan evaluations, interviews, focus group discussion and observations of classroom lessons. The positive findings of these studies showed an immediate effect of the professional development arrangements. However, the aim of most professional development programs is to be effective after their termination (Harvey & Hurworth, 2006). For this reason, an impact study was conducted to investigate the long-term effects of the professional development arrangements in the three studies on teachers' continued use of technology in science and mathematics teaching. The professional development arrangements in the prior studies had aimed at developing science and mathematics pre-service teachers' and practicing teachers' technology integration knowledge and skills, and adapted TPACK as its framework for describing the knowledge required by the teachers to effectively integrate technology in science and mathematics teaching. Teachers' learning took place through a workshop in which they explored technology applications for their subjects and collaboratively designed technology-enhanced science and mathematics lessons, which they used in their teaching and reflected upon with their peers. It was hypothesized, as shown by several studies (e.g., Agyei & Voogt, 2012; Alayyar & Fisser, 2011; Jimoyiannis, 2010) that the professional development arrangements that involved teachers in the collaborative design of technology-enhanced science or mathematics lessons would be promising for teachers' development of technology integration knowledge and skills and would have effects that were sustained over time.

Theoretical Underpinnings

Continuation and Transfer

In the studies discussed in this chapter, in particular the second study, transfer of training is assumed to be a prerequisite for continuation. Baldwin and Ford (1988) described continuation of the practices, knowledge, skills and beliefs in terms of the transfer of training, which is described as the degree to which trainees effectively apply the knowledge, skills and beliefs gained from training to a job. Baldwin and Ford presented a training transfer model with three parts; the training input factors, the training output, and the transfer conditions. According to Baldwin and Ford, there are three training input factors that determine the transfer and maintenance of knowledge, skills and beliefs over time. These factors include the training design, trainee characteristics and work environment.

The factors presented by Baldwin and Ford (1988) as determinant of the transfer of the training are presented in this study as key factors determining the continued use of technology in teaching and are categorized as follows: the training design is presented as *professional development factors*, which are comprised of the teachers' perceived valuing of the professional development arrangement (PDA), and the opportunity for continued learning (Pritchard & McDiarmid, 2005; Todorova & Osburg, 2010). Trainee characteristics are presented as *personal factors,* comprised of teacher beliefs, knowledge and skills, time and engagement (Buabeng-Andoh, 2012). The environment is presented as *institutional factors*, comprised of access to technology, support from the management, and environment (Almekhlafi & Almeqdadi, 2010; Eickelmann, 2011). Since the focus of the professional development arrangement in our studies was about technology integration in science and mathematics teaching, *technological factors* (cf. Buabeng-Andoh, 2012) were investigated in addition to the three factors presented by Baldwin and Ford (1988).

Professional development factors: Baldwin and Ford (1988) described these as training design factors, which include the incorporation of the learning principles, the sequence of training materials and the job relevance of the training content. Studies by Putman and Borko (2000), Todorova and Osburg (2010), and Voogt et al. (2011) reported that, for a successful professional development arrangement, teachers need to be involved in determining their learning needs and need to participate in the learning opportunities, which should be school-based, continuously supported, information-rich, and facilitate theoretical understanding and collaborative problem solving.

Personal factors are related to the individual teacher, such as knowledge and skills, beliefs, time availability and engagement in the use of technology in teaching (cf. Agyei, 2012; Baldwin & Ford, 1988). According to Fullan (2007), "educational change depends on what teachers do and think: it's as simple and as complex as that" (p. 129). Collis and Moonen (2001) argued that, if the teachers' first experience of working with technology fits with their experience and belief about the learning process, they will build up self-confidence towards technology and will engage in the use of technology in teaching. In addition, Guskey (2002) argued that teachers can accept a professional development program if they believe that it will expand their knowledge and skills, contribute to their growth and enhance their effectiveness in teaching.

The primary *institutional factor* influencing the continued use of technology after the professional development arrangement has ended is the value and belief system of the school, driven mainly by the school administration through motivation: rewards, incentives and financial support to teachers (Harvey & Hurworth, 2006; Pritchard & McDiarmid, 2005). Eickelmann (2011) described the institutional factors in terms of the support for individuals in schools, support from peers, participation in decision making and availability of technological tools (cf. Almekhlafi & Almeqdadi, 2010). Agyei (2012) and Almekhlafi and Almeqdadi (2010) reported that the limited technological resources in schools are one of the great impediments to the up-take of technology in schools.

Collis and Moonen (2001) mentioned two *technological factors* that affect continued use of technology: ease of use and effectiveness. Ease of use refers to the convenience, adequacy, reliability and user-friendliness of the technology, whereas effectiveness refers to the likelihood of long-term tangible benefits for the institution, improved learning and communication.

Based on the literature (Buabeng-Andoh, 2012; Eickelmann, 2011; Harvey & Hurworth, 2006), a conceptual model of the relationship between different factors that contribute to teachers' continued use of technology in their teaching is proposed (Fig. 20.1). In this model, the professional development arrangement is presented as the initiator of teachers' technology use in teaching, personal factors as the new

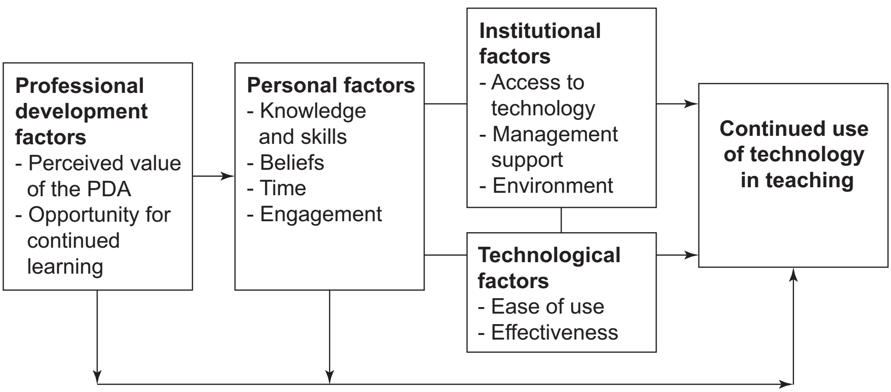


Fig. 20.1 A conceptual model of the factors determining teachers' continued use of technology in teaching

knowledge and skills, beliefs, motivation and time commitment that teachers developed through the professional development arrangement. This also represents the initial use of technology, which was described in Baldwin and Ford (1988) as learning and retention. For teachers to continue using technology in their teaching, the institutional factors and technological factors need to be taken into account. Unlike the training transfer model (Baldwin & Ford, 1988), which considers the design of the training, environment and trainees characteristics as all inputs, which lead to learning and retention (initial uses of technology) and transfer of training, the conceptual model presented in Fig. 20.1 interprets the relationships between each of the factors as influencing the teachers' continued use of technology in teaching.

The model represents the factors contributing to the continued use of technology in teaching after the termination of the professional development arrangement. While every type of factor (professional development, personal, institutional and technological) has a direct influence on the teachers' continued use of technology in teaching, through this model we can also indicate the relationships among factors.

Activity-Based Learning (ABL) in Mathematics

The learning that takes place in the studies in this chapter, particularly in study 1, is conceptualized by ABL, which describes a range of pedagogical approaches to teaching mathematics. Its core premises include the requirement that learning should be based on doing hands-on experiments and activities. The idea of ABL is rooted in the common notion that students are active learners rather than passive recipients of information and that learning, especially meaningful learning, requires engagement in activity (Churchill & Wong, 2002). Churchill (2004) argued that an active interaction with a learning object enables construction of learners' knowledge. Accordingly, he believed that the goal of ABL is for learners to construct mental models that allow for 'higher-order' performance such as applied problem solving and transfer of information and skills. This suggests that in ABL approaches, learners are actively involved, the environment is dynamic, the activities are interactive and student-centred and much emphasis is placed on collaboration and exchange of ideas. Mayer (2004) explained that a basic premise in constructivism is that meaningful learning occurs when the learner strives to make sense of the presented material (or activities) by selecting relevant incoming information, organizing it into a coherent structure, and integrating it with other organized knowledge. Thus, Mayer placed much emphasis on cognitive activity and learning by thinking instead of depending solely on learning by doing or learning by discussion. He emphasised guidance, structure, and focused goals when using an activity-based learning approach and recommended using guided discovery, a mix of direct instruction and hands-on activity, rather than pure discovery. Hmelo-Silver, Duncan and Chinn (2008) indicated that such guided inquiry approaches do not substitute content for practices; rather, they advocated that content and practices are central learning goals. Hmelo-Silver et al. (2008), argued that although it is challenging to develop instruction that fosters the learning of both theoretical frameworks and investigative practices through the development of guided learning environments, such approaches provide the learner with opportunities to engage in the scientific practices of questioning, investigation, and argumentation as well as learning content in a relevant and motivating context. Furthermore, they indicated that guided inquiry approaches with appropriate scaffolding involve the learner in the practices and conceptualizations of the discipline in a way that promotes construction of knowledge. This implies that the teachers' role is critical in designing and enacting an activity-based lesson in mathematics. Their roles should include prompting and facilitating discussion, focusing on guiding students by asking questions and designing activities that will lead learners to develop their own conclusions about mathematical concepts.

TPACK and Mathematics

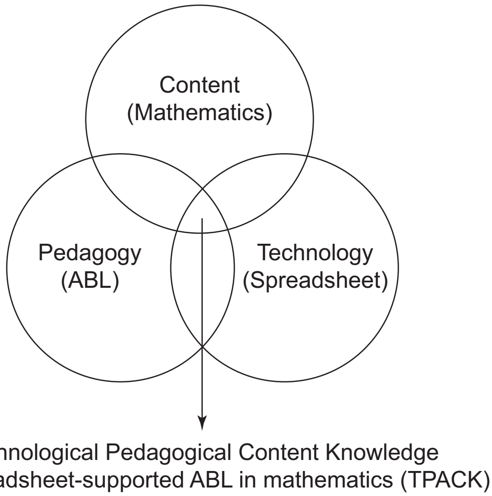
According to Niess, van Zee, and Gillow-Wilese (2010–2011), most teachers learned mathematics using paper and pencil, which limited the use of data for exploration and required time to calculate averages and create charts for every change in the variables. With the potential use of technologies in maths education, however, there is a need for teachers to create innovative learning experiences that truly engage the power of technology to involve students in higher-order thinking tasks. Thus, mathematics teachers are still confronted with challenges and questions about how and when to incorporate such technologies for teaching and learning various subject matter topics (Niess, 2011). For this reason, teachers' knowledge and skills for teaching with technology need to be developed (Niess, 2008). Mishra and Koehler outlined the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2005; Mishra & Koehler, 2006) in an effort to explain the types of knowledge teachers need in order to integrate technology into their teaching. TPACK emphasizes the comprehensive set of knowledge and skills teachers need to successfully integrate technology in their instructional practice (Koehler & Mishra, 2005).

Niess (2011) indicated that TPACK-related strategic thinking includes knowing when, where and how to use domain-specific knowledge and strategies for guiding students' learning with appropriate information and communication technologies. Considering the goal of engaging students in mathematical problem solving, for example, a mathematics teacher's TPACK must focus on thinking strategically about planning, organizing, implementing, critiquing results and plans for specific mathematics content and diverse student needs (Niess, Sadri, & Lee, 2007). This framework explicitly acknowledges that effective pedagogical uses of technology are deeply influenced by the content domain in which they are situated. Thus, the TPACK framework for using technology strategically in classroom instruction does not encourage technology use as a "stand-alone" support in mathematics teacher education but as a tool specifically and uniquely applied to mathematics instruction.

Subject-specific technological software such as spreadsheets have been used as a pedagogical tool for teaching and learning and have potentials that effective teachers can maximise to develop students' understanding and increased proficiency in mathematics. Niess et al. (2010–2011) indicated that spreadsheets contain features for modelling and analysing change, providing teachers with tools that rely on mathematics concepts and processes for accurate analysis. According to Niess et al. (2007), teachers who are able to design and enact spreadsheet lessons experience elementary concepts of mathematical modelling, expand their own conceptions of teaching mathematics with spreadsheets, investigate and expand their knowledge of instructional strategies for integrating spreadsheet learning activities, develop their own knowledge and skills regarding spreadsheets as tools for exploring and learning mathematics, and explore curricular materials that support learning with and about spreadsheets over an extended period of time. This redirection exposes the importance of teachers' strategic thinking and actions with respect to integrating technologies as learning tools in mathematics instruction. In our studies, TPACK was used as a conceptual framework to examine the knowledge and skills pre-service maths teachers developed about technology, pedagogy, and content as they designed and enacted activity-based lessons supported with spreadsheets. As shown in Fig. 20.2, the pedagogical knowledge examined in this study concerned ABL (PK_{ABL}).

The technological knowledge (TK_{ss}) learned by the pre-service teachers was spreadsheet applications for mathematics, because these were readily available in senior high schools and in teacher education colleges (Agyei & Voogt, 2011a, 2011b), user-friendly and had the potential to support students' higher-order thinking in mathematics (Niess et al. 2007). Content knowledge (CK_{maths}) was mathematics, which was the pre-service teachers' teaching subject area.

Fig. 20.2 TPACK framework for this study



Pre-service teachers' knowledge and skills that are needed to teach spreadsheet-supported ABL lessons in mathematics (first study) were operationalised as their TPACK, consisting of the following specific knowledge and skills:

- Content knowledge (CK_{maths}): knowledge about mathematical concepts.
- Pedagogical knowledge (PK_{ABL}): knowledge and skills about applying ABL teaching strategies.
- Technological knowledge (TK_{ss}): knowledge and skills about the affordances and constraints of spreadsheet use.
- Pedagogical content knowledge (PCK_{ABL}): knowledge and skills regarding how to apply ABL to teach particular mathematics content.
- Technological content knowledge *(TCK_{ss}):* knowledge and skills related to representing mathematical concepts in a spreadsheet.
- Technological pedagogical knowledge *(TPK_{ABL}):* knowledge and skills regarding how to use spreadsheets in ABL.
- Technological pedagogical content knowledge ($TPCK_{maths}$): knowledge and skills related to representing mathematical concepts with spreadsheets using ABL.

The Professional Development Arrangement

The professional development arrangement (PD) was based on 'learning technology by design' (Mishra & Koehler, 2006). The PD consisted of three stages: an introductory workshop for Design Teams (DTs), design of lessons in DTs and implementation of lessons by DT members. The workshop lasted for 2 weeks and prepared the pre-service teachers by giving them the theoretical foundation/concepts as well as practical skills. Exemplary materials consisting of two models of activity-based lessons supported with a spreadsheet that were prepared by the researcher and appraised by an expert with ample experience in the use of technology in teaching mathematics were a necessary component of the PD arrangement. Based on their level of experience, the teachers worked in teams of two during the design stage (6 weeks) and were challenged to select mathematics topics suitable for teaching with spreadsheets, and to make use of the affordances of the technology to design learning activities that would foster higher order thinking in mathematics. It was expected that the combination of a specific pedagogy (ABL) and a specific technology (spreadsheets) would encourage the pre-service teachers to apply their knowledge and skills in designing and enacting ABL lessons by employing a mix of direct instruction and hands-on activity to guide students through activities with spreadsheets to enhance student learning. Six activity-based lessons supported with spreadsheet were developed and enacted two times each at different stages of implementation. In the implementation stage (5 weeks), each lesson was enacted by teaching it to their peer pre-service teachers and in three secondary high schools. In the second study, the 'learning technology by design' approach was adopted. However, unlike other design research in which the identification of the problem is done through conducting a feasibility study or situational analysis study (cf. Agyei, 2012; Bakah, 2011; Nihuka, 2011), this research began with a *proof of concept study* in which the problem identification was based on the previous research and an in-depth review of the literature. According to Plomp (2009), "informed by prior researches and review of relevant literature, researchers in collaboration with practitioners can design and develop workable and effective interventions by carefully studying successive versions (or prototypes) of interventions in their target contexts, …" (p. 13). From the literature, it was revealed that, although technology was available in schools in Tanzania and teacher training colleges were training teachers to integrate technology in teaching, technology uptake in schools was low. Thus, a proof of concept study was conducted with the preservice teachers to find out if the professional development approach that had been successful in Ghana (Agyei, 2012) and Kuwait (Alayyar & Fisser, 2011) could also be applied successfully in Tanzania to develop teachers' technology integration knowledge and skills.

The professional development arrangement presented in this study adopted the "plan, teach, evaluate, re-plan" approach proposed by Peker (2009) for pre-service teachers. This approach was implemented by Jimoyiannis (2010) for in-service teachers as "planning, development, evaluation and rethinking". Unlike Peker (2009) and Jimoyiannis (2010), who began their programs with planning, the professional development arrangement presented in this study began with an introductory workshop to introduce the concept of technology integration in science and mathematics teaching, followed by collaborative designing in teams (planning), lesson implementation (teaching), reflection (evaluation) and re-designing (re-plan). During the collaborative design of technology-enhanced lessons in teams, teachers were provided with support from a facilitator and/or an experienced science and educational technology expert, collaboration guidelines, exemplary lessons, and online learning materials. The availability of such materials provided a useful opportunity for teachers to share knowledge, skills, experiences and challenges related to technology integration in science and mathematics teaching, and thus, to learn from each other (cf. Agyei, 2012; Jimoyiannis, 2010).

Research Questions

The main research question of the first study was: *To what extent did pre-service teachers' knowledge and skill in designing and enacting spreadsheet-supported ABL lessons develop and impact secondary school students' learning outcomes?* This study was an in-depth investigation of the knowledge and skill needed by pre-service mathematics teachers to design and enact spreadsheet-supported ABL lessons, in which both quantitative and qualitative data were used. To investigate the impact of the spreadsheet-supported ABL lessons on their students' outcomes, a pre-posttest experimental control group design was used.

The second study was conducted to determine the likelihood of the pre-service and in-service teachers' continued use of technology in their science and mathematics teaching after the termination of the professional development arrangement. The main research question addressed in this study was "*What factors affect the continued use of technology in science and mathematics teaching among pre-service and in-service teachers who attended the professional development arrangements?*"

Methods

Participants

Twelve pre-service mathematics teachers participated in the first study. The pre-service teachers were in their final year of the mathematics teacher education programme at University of Cape Coast (UCC) in Ghana. The 4-year teacher training programme allows pre-service teachers to teach at junior and senior high schools when they graduate. The average age of these pre-service teachers was 26 years. The senior high school students ($n = 297$) who participated in the study were from three different high schools. These high school students (from years 1, 2 and 3) were taught lessons by the pre-service teachers. Two hundred and twenty-five of them participated in the activity-based lessons supported with a spreadsheet, while 72 of them were taught with the traditional approach and served as a control group.

Participants in the second study were 13 teachers who had participated in the professional development arrangement as pre-service teachers from a teacher training college, and are currently working as school teachers or college tutors. In this study, they are referred to as the pre-service science and mathematics teachers. The study also included 29 in-service teachers from three secondary schools, which are presented anonymously as Schools A, B, and C. Schools A and B were government schools, each with one computer lab and approximately 30 computers, of which only one computer at school A and two at school B were working. School C was a private school with three computer labs and approximately 20 working computers in each lab.

Instruments

In the first study, data collection addressed how pre-service teachers perceive as well as demonstrate their knowledge and skill, and the impact on students of the activity-based lessons supported with spreadsheet is presented. Multiple data sources were used.

A TPACK lesson plan rubric was adapted from the Technology Integration Assessment Rubric (TIAR), which Harris, Grandgenett, and Hofer (2010) created and tested and found to be a valid and reliable instrument to assess TPACK evident in teachers' written lesson plans. While TIAR is a general rubric to determine TPACK in lesson plans, adaptations were made to fit it to TPACK for spreadsheet-supported ABL in mathematics. The rubric consisted of seven different criteria and was scored as: not at all (1), minimal (2) and strong (3). Interrater reliability (Cohen's $\kappa = 0.91$) was calculated, using a sample of three lesson plans scored by two raters. The lessons were first coded (based on the TPACK constructs) and then assessed using the rubric.

An observation rubric adapted from a valid and reliable TPACK-based Technology Integration Observation Instrument (Hofer, Grandgenett, Harris, & Swan, 2011) was developed and used to assess TPACK in observed instruction. Adaptations were made to be able to observe TPACK for spreadsheet-supported ABL in mathematics. The observation instrument consisted of 20 items, which could be scored as: not at all (1), partly observed (2) and observed (3). The interrater reliability (Cohen's κ) for assessments of two observed lessons was $\kappa = 0.94$.

The pre-service-teachers' TPACK questionnaire, which was also used, included items that addressed the pre-service teachers' self-efficacy regarding their TPACK, adapted from Schmidt, Baran, Thompson, Mishra, Koehler and Shin (2009); responses used a five-point Likert scale format (from strongly agree (1) to strongly disagree(5)). Cronbach's alpha reliability estimates got this instrument range from 0.75 to 0.93 (Schmidt et al., 2009). The instrument was adapted and administered twice, before and after the intervention.

Teachers' responses in the pre-post survey indicated their own development in the perceived knowledge and skills needed to design and enact spreadsheet-supported ABL lessons. To explore pre-service teachers' knowledge and skills needed to design and enact spreadsheet-supported ABL lessons, interviews were conducted after each teaching session. Two raters coded the interview data using a sample of 5 interviews (from 5 teachers). The interrater reliability (Cohen's κ) was $\kappa = 0.92$.

The researchers' logbook was used to maintain a record of activities and events occurring during the design and enactment of the ABL lessons supported with a spreadsheet. The logbook entries complemented findings from the other data collection instruments. Information recorded in the logbook was analysed qualitatively using data reduction techniques in which major themes (students' participation; teachers' role; use of lesson materials and challenges in enacting ABL lessons supported with a spreadsheet) were identified and clustered (Miles & Huberman, 1994).

For each of the designed lessons, a test was developed by the pre-service teachers, and reviewed by the researcher, to determine student learning outcomes. The same test was administered pre- and post-instruction to ascertain the impact of the ABL lessons supported with a spreadsheet, for each of the six lessons enacted. Furthermore, two pre-service teachers developed the same lessons and taught them in a teacher-centred approach without using the spreadsheet-supported ABL pedagogical approach in the same school for comparison purposes.

Data for the second study were collected by using two kinds of instruments: a questionnaire and an interview. A questionnaire was used to assess the extent to which teachers continued to use technology in their science and mathematics teaching, as well as the factors (if any) that determined the teachers' continued use of technology in their teaching. The questionnaire was modified from Agyei (2012) and new items were included. The scale for this questionnaire was divided into two sub-scales: questions related to the continued use of technology and personal factors used a five-point Likert scale: strongly disagree (1) and strongly agree (5). Items related to professional development, institutional, and technological factors used a four-point Likert scale: not at all (1), a little (2), somewhat (3) and a lot (4).

A semi-structured interview guide was developed by the second author to assess the continuation of the use of technology in teaching and the professional development, institutional, personal and technological factors that affected the teachers' continued use of technology in teaching. Three teachers from each group in the study: pre-service, school A, school B, and school C teachers, were randomly selected to participate in the interview. Pre-service teachers participated in the interview through a phone call, while teachers from schools A, B and C, participated in a face-to-face interview. Examples of interview questions were: (1) How often do you use technology in your teaching? (2) What are the factors determining technology integration in teaching at your school? A random sample of 4 interviews was coded by a second person. The inter-coder reliability κ was 0.84.

The data from the questionnaire were analyzed to compute means and standard deviations. An ANOVA was carried out to test the difference in the means between the participant groups. The qualitative data from the interviews were transcribed and coded by using the codes that were generated from the study's theoretical framework (deductive coding) (Miles & Huberman, 1994).

Main Findings

In the first study, pre-service mathematics teachers collaboratively designed and used spreadsheet teaching materials to enact an ABL lesson within a mathematics classroom context. In particular, the study sought to measure the extent to which the pre-service teachers were able to develop and demonstrate the knowledge and skill needed to design and enact spreadsheet-supported ABL lessons and the impact of pre-service teachers' enactment of the lessons on secondary school students' learning outcomes. The lesson documents and lesson enactment showed that the pre-service teachers employed a mix of direct instruction and hands-on activity to guide students through activities in which the students explored, conjectured, verified, generalized, and applied results to other settings and realistic mathematical problems, consistent with other studies (Hmelo-Silver et al., 2008; Mayer, 2004). The teachers used the spreadsheet extensively to give greater opportunity to verify results and consider general rules, make links between spreadsheet formulae, algebraic functions and graphs, analyse and explore number patterns and graphs within a briefer time and allow for many numerical calculations simultaneously, to help their students explore mathematics concepts and perform authentic tasks. The findings support arguments that a spreadsheet-supported ABL approach fostered learner-centred classroom practices and has potential for improving mathematics achievement in senior high schools.

This confirms similar studies (Özgün-Koca, Meagher, & Edwards 2010) that have found that pre-service teachers' understanding of technology shifted from viewing technology as a tool for reinforcement to viewing technology as a tool for developing student understanding of mathematical concepts.

The findings of the first study also indicated that teachers demonstrated knowledge and skills in designing and enacting ABL lessons supported with a spreadsheet in their lesson plan products and observed instruction. Thus, as novice teachers, the new experience with spreadsheet and ABL impacted their knowledge and skills regarding all of the TPACK constructs. This was confirmed by their perceived development in the knowledge and skill needed to design and enact spreadsheet-supported ABL lessons, as observed by significant gains in all the TPACK components of the teachers' self–reported data.

The first study also showed that ABL pedagogy can play a vital role in enhancing pre-service teachers' skill and their experience with integrating technology in their future classes. The ABL approach prompted clearly defined roles for both students and teachers. Students worked collaboratively in groups, had the opportunity to evaluate their own work and that of others by sharing their evaluations. The role of the teachers, on the other hand, was more as facilitators than dispensers of knowledge; they managed the context and setting and assisted students in developing mathematical concepts through activities.

Findings from the second study revealed that, while the pre-service teachers and teachers from school B used technology for teaching, teachers from schools A and school C used technology mostly for administrative purposes. Earlier findings by Hare (2007) and Swarts and Wachira (2010) reported the frequency of teachers' use of technology for administrative rather than instructional purposes. However, the findings presented for pre-service teachers and teachers at school B are in line with those from study 1 who reported successful transfer of training to the job, after a similar professional development arrangement.

Several factors contributed to the continued use of technology in their teaching by the teachers who attended the professional development arrangement.

Teachers' perceived valuing of the professional development was a significant predictor of teachers' continued use of technology in their teaching. Teachers reported satisfaction with the content, sequence and relevance of the professional development arrangement they attended. They further reported that collaborative design of technology-enhanced science lessons in teams, implementation of the designed lessons and reflection with peers, were necessary components for developing their understanding of various technological tools that can support learning, and of how they can improve learning of difficult science topics through the use of technology. According to Jimoyiannis (2010), teachers' collaborative design of technology-enhanced science lessons is a promising professional development arrangement for developing teachers' technology integration knowledge and skills.

Analysis of personal factors showed that knowledge and skills was the only significant predictor of the teachers' continued use of technology in their teaching. Although these findings agree with those of Eickelmann (2011) and Todorova and

Osburg (2010), who reported that knowledge and skills was an important determinant of technology integration, they differed from those of Agyei (2012), who reported that perceptions (belief) was a significant predictor of the continued use of technology in teaching. The findings in this study showed that belief negatively predicted the continued use of technology in teaching. This implies that although some teachers did not use technology in their teaching, they had a positive belief about the use of technology in teaching.

Findings on the institutional factors showed that access to technology and support were significant predictors of the teachers' continued use of technology in their teaching. Of the three measures of institutional factors assessed in this study, access, support and environment, only environment was an insignificant predictor. Most of the teachers who did not integrate technology in teaching reported the lack of access to technology and support as factors that hindered their integration of technology. However, both the teachers who continued using technology and those who did not experienced similar problems related to the environment (lack of electricity, cables, etc.).

Further, the analysis of technological factors revealed that ease of use of technology was a significant predictor of the teachers' continued use of technology in their teaching. Although the majority of teachers reported that technology was effective in science and mathematics teaching, they differed on the ease of use. Some teachers reported that technology use is easy, while others said that it depends on the choice of technology or found it difficult in lesson preparation but easy in teaching. The combination of all significant factors (perceived value of the professional development, knowledge and skills, access to technology, support and ease of use of technology) showed that knowledge and skills, access to technology and ease of use of technology were significant predictors of the teachers' continued use of technology in their teaching. The perceived value of professional development and support from the management were not significant.

The findings of the second study led to the conclusion that a long-term impact of a professional development arrangement in the context of Tanzania depends on teachers' technology integration knowledge and skills, access to technology and the ease of use of the available technology. Although Baldwin and Ford (1988) indicated that the professional development factor can directly lead to transfer of training, the findings in this study showed that the professional development factor does not necessarily lead to the continued use of technology in teaching; instead it is an important aspect for the change in teachers' knowledge and skills regarding integrating technology in their teaching, which in turn has an effect on their use of the technology available at the school, provided that it is easy to use. Moreover, Eickelmann (2011) quoted several studies indicating that management support is the most important and supportive factor for teachers' continued use of technology (cf. Hennessy, Harrison, & Wamakote, 2010). However, our study showed that management support was not a significant predictor of the teachers' continued use of technology in their teaching. The findings from interviews indicated that teachers were more likely to continue using technology in teaching in schools in which they were supported by the management than in those in which teachers were not supported.

Since the analysis of the institutional factors determining the continued use of technology in teaching showed that support from the management was a significant predictor, it is possible that management support acts as a catalyst, rather than having a direct impact on the continued use of technology in teaching. The teachers' continued use of technology can take place if the management can provide incentives to motivate teachers to use technology in their teaching (cf. Hennessy et al., 2010): (1) ensure that the technological tools are available and maintained for ease of use; (2) encourage teachers to use technology in their teaching; and (3) offer opportunities for teacher training to enhance their technology integration knowledge and skills.

Discussion

In spite of the advantages of the pedagogical approach used in the first study, the teachers reported some difficulties in applying their knowledge and skill in designing and enacting activity-based lessons supported with spreadsheet. The areas they identified to be particularly challenging and difficult included: selecting and integrating appropriate spreadsheet tools and relevant spreadsheet applications in designing authentic learning activities for selected topics. It is apparent that the range of spreadsheet capabilities is limited and that for many mathematics concepts spreadsheet applications are not relevant. As a result, most teachers might have experienced difficulty in making spreadsheet application choices and in matching the learning activities that they employed in their instructional plans. The context-sensitive factor related to how pre-service teachers have been deep-rooted in a teacher-centred learning approach could have influenced their thinking and practices. A concern regarding time was reiterated by the teachers, indicating that conducting spreadsheet-supported ABL lessons involved a lot of time and required a type of subject-specific training with technology. These drawbacks notwithstanding, the spreadsheet-supported ABL lessons impacted their secondary students' learning outcomes. The pre-post test scores for the lessons showed significant improvement after all the lessons. The mean gains in the spreadsheet-supported ABL approach compared to the traditionally taught lessons showed a significance difference, with a medium to high effect size, which confirms the findings of previous studies (cf. Keong, Horani, & Daniel, 2005) that technology use improves the way mathematics is taught and enhances students' understanding of basic concepts, and has a positive effect on student achievement in mathematics (cf. Beauchamp & Parkinson, 2008; Bottino & Robotti, 2007). Thus, the spreadsheet environment appeared useful for engaging pre-service teachers in the design of learning activities to support the mathematics learning of students, such as: discussing presentations, collecting data (e.g., on the co-ordinates of an object), working in teams, making predictions. This variety of learning activities allowed the pre-service teachers to orchestrate student learning in various ways (cf. Drijvers, Doorman, Boon, Reed, & Gravemeijer, 2010). This is the kind of pedagogical reasoning (cf. Heitink, Voogt, Verplanken, va Braak & Fisser, 2016; Webb & Cox, 2004;) that pre-service teachers need to undertake in their planning and teaching of ICT-enhanced lessons.

The results in the first study indicated that exposing teachers to ABL based lessons supported with a spreadsheet is a good way to help pre-service teachers develop deeper connections between their subject matter, instructional strategy and spreadsheet application use knowledge-base of TPACK. Such a conclusion poses a question about TPACK's applicability in different contexts and with different technologies, assessing teachers at a more generic level. Therefore, the study supports the contention that for teachers to understand and develop knowledge and skills related to TPACK in a valid and reliable way, it is important for them to focus on a specific content as well as a specific pedagogical approach into which a specific technology can be integrated. This aligns with Shulman's (1986) idea of a teacher's PCK, characterized as:

> knowledge of the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations … including an understanding of what makes the learning of specific concepts easy or difficult. (p. 9)

The conceptual model of influences on the continued use of technology in teaching presented in Fig. 20.1 is supported by the findings in this study, but with fewer critical variables. The model may be explained as follows: the professional development arrangement, which was mainly collaborative design in teams, initiated the teachers' learning of technology integration knowledge and skills (personal factor); the availability of supportive conditions such as access to technology (institutional factor) and ease of use of technology (technological factor) enabled teachers to use the knowledge and skills gained from the professional development for continued use of technology in their teaching (Fig. 20.3). While in this study, management support was conceptualized as one of the institutional factors, in the final model we consider that support from the management is interposed between the personal factors and the institutional and technological factors. In that way, management support becomes a catalyst for the interaction between teachers' technology integration

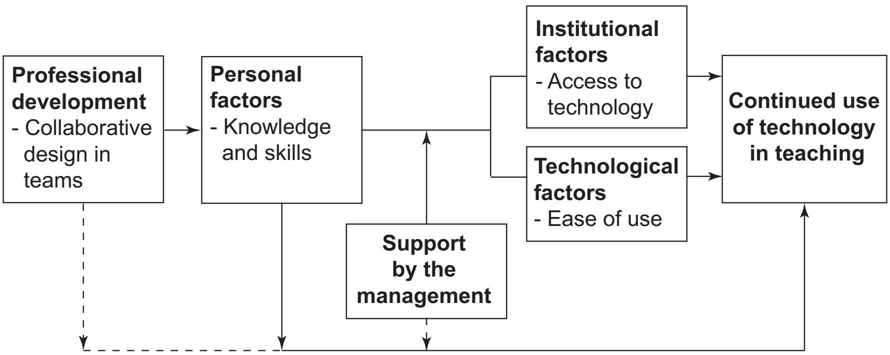


Fig. 20.3 A conceptual model of teachers' continued use of technology after the professional development arrangement

knowledge and skills, the technology available at school and its ease of use. The management becomes important in motivating teachers to use the knowledge and skills gained from the professional development, through providing incentives and rewards for technology uses (personal factor), ensuring availability of the technological tools at school (institutional factor), and ensuring that the technology is maintained (repaired) to make it easy for teachers to use (technological factor) (see the modified model in Fig. 20.3).

From the model (Fig. 20.3), the relationship between the professional development, support from the management and continued use of technology is represented by a dotted line, because the impact of the professional development and management support was insignificant. However, the impact of professional development was noticeable through the enhancement in teachers' knowledge and skills regarding integrating technology in their teaching. On the other hand, the impact of management support was evident in the differences in technology use between schools in which teachers were supported by the management and those which they were not.

The findings in the second study can have implications for future professional development arrangements that aim to develop technology integration knowledge and skills. First, although the professional development factor had insignificant impact, we consider it important for the teachers' continued use of technology in their teaching, because it was the initiator of the teachers' development of technology integration knowledge and skills. Second, a long-term impact of the professional development arrangement depends on the teachers' technology integration knowledge and skills, access to technology and the ease of use of the available technology. Third, although management support was not a significant predictor, we consider it essential for teachers' continued use of technology in their teaching. The findings revealed that schools that had support from the management had better implementation than those that had little support. Thus, support is considered to be an important catalyst for the teachers to put the knowledge and skills developed from the professional development into practice and to utilise the available technology at school for their teaching, provided that the technology is easy to use. Based on the findings of this study, we are confident in describing support from management as a factor that comes between institutional factors and technological factors, and personal factors.

The model presented provides key information about the factors determining the teachers' continued use of technology in their teaching (see also Niederhauser et al., 2018). Moreover, the professional development arrangement assessed in this study seemed to have a promising impact on the teachers' continued use of technology in their teaching. However, future professional development arrangements could take into account the involvement of the school management in the design, implementation and evaluation of the professional development arrangement. Moreover, future studies could also investigate whether or not the school management should be considered as among the institutional factors or should stand alone as the overseer of the whole process (i.e., teachers' learning process, availability of technology and the extent to which technology is easy to use).

References

Agyei, D. D. (2012). *Preparation of pre-service teachers in Ghana to integrate Information and Communication Technology in teaching mathematics*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Agyei, D. D., & Voogt, J. M. (2011a). ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and Information Technologies, 16*(4), 423–439.

Agyei, D. D., & Voogt, J. M. (2011b). Exploring the potential of the will skill tool model in Ghana: Predicting prospective and practicing teachers' use of technology. *Computers & Education, 56*(1), 91–100.

Agyei, D. D., & Voogt, J. M. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology, 28*(4), 547–564.

Alayyar, G., & Fisser, P. M. (2011). Developing pre-service teachers' competencies for ICT integration through design teams in science teacher preparation. *International Journal of Learning Technology, 6*(2), 125–145.

Almekhlafi, A. G., & Almeqdadi, F. A. (2010). Teachers' perceptions of technology integration in the United Arab Emirates school classrooms. *Educational Technology & Society, 13*(1), 165–175.

Bakah, M. A. (2011). *Teacher professional development through collaborative curriculum design in Ghana's polytechnics*. Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology, 41*, 63–105.

Beauchamp, G., & Parkinson, J. (2008). Pupils' attitudes towards school science as they transfer from an ICT-rich primary school to a secondary school with fewer ICT resources: Does ICT matter? *Education and Information Technologies, 13*, 103–118.

Bottino, R. M., & Robotti, E. (2007). Transforming classroom teaching and learning through technology: Analysis of a case study. *Educational Technology & Society, 10*(4), 174–186.

Buabeng-Andoh, C. (2012). Factors influencing an exploration of teachers' adoption skills, perceptions and integration practices of information ICT in teaching and communication learning in the Ghanaian second-cycle schools. *Contemporary Educational Technology, 3*(1), 36–49.

Churchill, D. (2004). Effective use of technology for construction of learners' mental models. In A. Khoo, M. A. Heng, L. Lim, & R. P. Ang (Eds.), *Innovation and diversity in education* (pp. 207–223). Singapore, Singapore: McGraw Hill (Asia).

Churchill, D., & Wong, P. (2002). *Design of activity-based eLearning*. Paper presented at the International Conference on Information and Communication Technology, Technologies in Education, Badajoz, Spain.

Collis, B., & Moonen, J. (2001). *Flexible learning in a digital world: Experiences and expectations*. London: Kogan Page.

Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool: Whole-class teaching behavior in the technology-rich mathematics classroom. *Educational Studies in Mathematics, 75*(2), 213–234.

Eickelmann, B. (2011). Supportive and hindering factors to a sustainable implementation of ICT in schools. *Journal of Educational Research Online, 3*(1), 75–103.

Fullan, M. (2007). *The new meaning of educational change* (4th ed.). New York: Teachers College Press.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice, 8*(3/4), 381–391.

Hare, H. (2007). Survey of ICT in education in Tanzania. In G. Farrell, S. Isaacs, & M. Trucano (Eds.), *Survey of ICT and education in Africa (volume 2): 53 country reports*. Washington, DC: infoDev/World Bank.

Harris, J., Grandgenett, N., & Hofer, M. (2010). Testing a TPACK-based technology integration assessment rubric. In D. Gibson & B. Dodge (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2010* (pp. 3833–3840). Chesapeake, VA: AACE.

Harvey, G., & Hurworth, R. (2006). Exploring program sustainability: Identifying factors in two educational initiatives in Victoria. *Evaluation Journal of Australasia, 6*(1), 36–44.

Heitink, M., Voogt, J., Verplanken, L., van Braak, J., & Fisser, P. (2016). Teachers' professional reasoning about their use of technology. *Computers & Education, 101*, 70–83.

Hennessy, S., Harrison, D., & Wamakote, L. (2010). Teacher factors influencing classroom use of ICT in Sub-Saharan Africa. *Itupale Online Journal of African Studies, 2*, 39–54.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2008). Scaffolding and achievement in problem-based inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99–107.

Hofer, M., Grandgenett, N., Harris, J., & Swan, K. (2011). *Testing a TPACK-based technology integration observation instrument*. Paper presented at the Proceedings of Society for Information Technology & Teacher Education International Conference 2011, Chesapeake, VA: AACE.

Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers' professional development. *Computers & Education, 55*, 1259–1269.

Keong, C., Horani, S., & Daniel, J. (2005). A study on the use of ICT in mathematics teaching. *Malaysian Online Journal of Instructional Technology, 2*(3), 43–51.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Mayer, R. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*(1), 14–19.

Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed.). London: Sage Publications.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Niederhauser, D. S., Howard, S. K., Voogt, J., Agyei, D. D., Laferriere, T., Tondeur, J., et al. (2018). Sustainability and scalability in educational technology initiatives: Research-informed practice. *Technology, Knowledge and Learning, 23*(3), 507–523.

Niess, M. L. (2008). *Knowledge needed for teaching with technologies – Call it TPACK* (pp. 9–10). AMTE Connections, Spring.

Niess, M. L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educational Computing Research, 44*(3), 299–317.

Niess, M. L., Sadri, P., & Lee, K. (2007). *Dynamic spreadsheets as learning by instructors: Developing teachers' technology pedagogical content knowledge (TPCK)*. Paper presented at the American Educational Research Association Annual Conference, Chicago, IL.

Niess, M. L., van Zee, E., & Gillow-Wilese, H. (2010–2011). Knowledge growth in teaching mathematics/science with spreadsheets; Moving PCK to TPACK through online professional development. *Journal of Digital Learning in Teacher Education, 27*(2), 42–52.

Nihuka, K. (2011). *Collaborative course design to support implementation of e-learning by instructors.* Doctoral dissertation. Enschede, The Netherlands: University of Twente.

Özgün-Koca, S. A., Meagher, M., & Edwards, M. T. (2010). Preservice teachers' emerging TPACK in a technology-rich methods class. *The Mathematics Educator, 19*(2), 10–20.

Peker, M. (2009). The use of expanded microteaching for reducing preservice teachers' teaching anxiety about mathematics. *Scientific Research and Essays, 4*(9), 872–880.

Plomp, T. (2009). Educational design research: an introduction. In T. Plomp & N. Nieveen (Eds.), *An introduction to educational design research*. Proceedings of the seminar conducted at the East China Normal University, Shanghai (PR China) November 23–26, 2007 (pp. 9–36). Enschede, The Netherlands: SLO.

Pritchard, R., & McDiarmid, F. (2005). Promoting change in teacher practices: Investigating factors which contribute to sustainability. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Identities cultures and learning spaces.* Proceedings of the 29th annual conference of the Mathematics Education Research Group of Australasia (pp. 432–439). Sydney: MERGA.

Putnam, R. P., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teachers' learning? *Educational Researcher, 29*(1), 4–15.

Schmidt, D. A., Baran, E., Thompson, A. S., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education, 42*(2), 123–149.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Swarts, P., & Wachira, E. M. (2010). *Tanzania: ICT in education: Situational analysis*. Dar-Es-salaam, Tanzania: Global e-School and Communities Initiative.

Todorova, A., & Osburg, T. (2010). Professional development program for technology integration: Facilitators and barriers to sustainable implementation. *Literacy Information and Computer Education Journal, 1*(1), 59–66.

Voogt, J. M., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J. M., et al. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education, 27*(8), 1235–1244.

Webb, M., & Cox, M. (2004). A review of pedagogy rated to information and communications technology. *Technology, Pedagogy and Education, 13*(3), 235–286.

Zehetmeier, S. (2009). *Sustainability of professional development*. Proceedings of CERME 6. Lyon, January 28th–February 1st 2009. Retrieved on July 12th, 2012 from http://ife.ens-lyon.fr/publications/edition-electronique/cerme6/wg10-27-zehetmeier.pdf

Part VI
Conclusions and Perspectives: Editorial Introduction

Conclusions and Perspectives

In the final section, two chapters draw conclusions and discuss perspectives on the impact of design on curriculum innovation.

The first chapter by Bill Penuel integrates insights from earlier chapters in this volume by naming ways how co-design can support building collective capacity in educational systems for equitable change. By targeting infrastructure rather than innovations in isolation, co-design with teachers has the potential to bring about more coherent guidance for teachers and more equitable learning opportunities for students. Infrastructuring requires a shift in goals from supporting teacher learning to democratizing innovation and from sustaining particular curricular programs and interventions to building capacity to design and test solutions to emergent problems of practice. Design-Based Implementation Research (DBIR), an integrative approach to organizing research and development teams within long-term research-practice partnerships, provides a useful framework for infrastructuring efforts within large educational systems.

The second chapter by Susan McKenney discusses the human, material, and structural aspects of infrastructure. Collaborative curriculum design is a process through which two objectives are typically pursued, namely, the development of curriculum and materials for use in everyday classroom settings, and through the discussions that this process engenders, teacher professional development. Yet, as described in the preceding chapters, achieving these goals is not easy. While many factors influence design team outcomes, the human, material, and structural aspects of infrastructure that are present in a collaborative design context are particularly important. First, the people engaging directly and indirectly in collaborative curriculum design process influence both its process and its outcomes. Second, teacher design teams can be facilitated or hampered by the material resources that they have available to them or that they create for themselves. Third, the structural conditions under which teams work, including policies, norms and routines, wield powerful influence on their motivation, feasibility and effectiveness. This chapter revisits key findings from the cases given throughout this book, in light of the processes and outcomes of collaborative curriculum design, as well as the human, material, and structural aspects of infrastructure that can support them. The chapter concludes with a synthesis of these insights (which constitute recommendations for practice and policy), discussion of the findings, and recommendations for future research.

Chapter 21
Co-design as Infrastructuring with Attention to Power: Building Collective Capacity for Equitable Teaching and Learning Through Design-Based Implementation Research

William R. Penuel

The chapters in this volume explore different ways that co-design of curriculum can make learning more relevant to teachers and students, support teacher learning, and promote the sustainability of particular innovations. Many of the chapters conclude that in fact, there is great potential for co-design to support each of these aims. Co-design, for example, can promote teacher ownership over the curriculum, including when reform goals that guide development are set by policy makers who are far from the classroom (Westbroek, de Vries, Walraven, Handelzalts, & McKenney, this volume). Co-design can facilitate "curriculum renewal" among in-service teachers—that is, a transformation in teachers' goals for students and pedagogical approaches. For pre-service teachers, co-design can support integration of technology into teaching (Agyei & Kafyulilo, this volume; Alayyar & Fisser, this volume). Further, teachers can continue to learn from the implementation process (Huizinga, Nieveen, & Handelzalts, this volume). Finally, there is some evidence presented in this volume that co-design facilitates sustainability by creating processes for ongoing curriculum renewal.

But the chapters in this volume also explore limitations or boundary conditions under which co-design can produce these positive outcomes. For one, the organizational conditions matter. Teachers need time not just to develop curriculum, but also to learn the skills of curriculum design and to implement and evaluate it using a cycle of iterative testing and revision (Albashiry, this volume; Handelzalts, Nieveen, & Van den Akker, this volume). And since most curriculum design projects require coordination among actors at different levels of systems and within organization, systems of formal and informal communication to ensure coherence are needed

W. R. Penuel (✉)
School of Education and Institute of Cognitive Science, University of Colorado Boulder, Boulder, CO, USA
e-mail: William.Penuel@colorado.edu

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_21

(Handelzalts, et al., this volume). A well-facilitated design process helps teachers keep from floundering and take into considerations related to how particular curriculum structures and pedagogies can best support student learning (Handelzalts et al., this volume). Further, careful attention to cultural and political dimensions of design processes and implementation—related to national, regional, and school-level processes—is required for co-design to succeed (Agyei & Kafyulilo, this volume; Gervedink Nijhuis, this volume).

These conditions are difficult to create for all design teams, and even when they are in place, implementation of co-designed materials still varies (Huizinga, Nieveen, & Handelzaltz, this volume). And in a number of instances cited in the chapters, co-design resulted more in a reproduction of existing pedagogies, rather than their transformation. These challenges raise the important question, *Is there any way to make co-design more reliable as a strategy for promoting transformational change in educational systems?*

I argue in this chapter that we can make co-design more reliable, but that it requires a shift in how we think about the purposes of co-design and also its relationship to the organizational contexts in which co-design takes place. To summarize this argument briefly, co-design must be embedded within long-term research-practice partnerships in which external partners (e.g., researchers) and teachers in joint work to evaluate and iterate upon both the processes and products of design. Second, design must focus on the goal of promoting collective capacity and be motivated by a concern for democratizing the process of innovation and professional renewal. Third, to accomplish this goal, design must focus both on curriculum and on redesigning the infrastructures that support the effective implementation of curricula. I illustrate what this approach looks like by drawing on the experiences of a research-practice partnership in Colorado (USA).

The Importance of Research-Practice Partnerships for Implementing and Sustaining Change in Educational Systems

A typical cooperative engagement between an educational organization and a team of researchers is short-term, and the goals are largely defined by the educational organization, the researchers, or some external policy that both partners are implementing. Many of the projects described in the volume—especially those involving international cooperation—focused on supporting the goals of educational organizations. By contrast, in the United States, research and development projects involving co-design have often been driven by researchers' goals (e.g., Penuel, Roschelle, & Shechtman, 2007). Many of the examples from the Netherlands in this volume represented occasions where co-design served the goals of policymakers, or where as Westbroek and colleagues put it, co-design was a bottom-up strategy for a top-down innovation. When the initiative or grant ends, the cooperation often ends, and it is difficult to sustain innovations that have been developed and tested without the ongoing support and involvement of external partners (Fishman, Penuel, Hegedus, & Roschelle, 2011).

In a research-practice partnership, goals for research and development are collaboratively defined, and the commitment to working together is both long-term and open-ended. Research-practice partnerships are intentionally organized collaborations focused on investigating problems of practice and solutions for improving outcomes in educational systems (Coburn & Penuel, 2016). The phrase "intentionally organized" here connotes some formal arrangement and routine ways of interacting with one another—such as through co-design of curriculum materials—that help partners arrive at deeper, shared understanding of problems and to design, test, and iterate on solutions to those problems. And while the focus is always on improving practice, partnerships can and do develop knowledge and tools that are useful for other researchers and partnerships (Henrick, Cobb, Penuel, Jackson, & Clark, 2017). Further, the understanding of the problems to be addressed is a *negotiated* understanding—one that reflects the concerns and goals of different stakeholders in the partnership (Penuel, Coburn, & Gallagher, 2013).

It is partners' commitment to following the "contours of a problem" (Donovan, 2013) wherever the research and development process may lead that makes them particularly valuable for improving the reliability of outcomes of co-design. Research-practice partnerships do not just develop and test innovations; they document and take action to reduce barriers to implementation that make innovations less successful (Penuel & Gallagher, 2017). Research evidence is always formative—even when findings are ultimately published in academic journals. And partnerships develop new lines of work continuously that arise from problems of implementation, as well as those that arise from emerging priorities, concerns, and interests of the partnership. When successful, partnerships add value to both the research and practice organizations, and they lead not just to renewal of educational resources like curriculum, but to professional renewal—that is, to the sense among participants that they are doing meaningful work that energizes them (Frumin, 2018).

Reframing the Aims of Co-design

Educational organizations such as schools and districts, as well as educational ecosystems comprised of formal and informal organizations in a community, are first and foremost concerned with improving outcomes for learners. While leaders in these organizations recognize the central importance of curriculum materials, interventions, and practices in helping accomplish these outcomes, they view these as *tools* or *means* to accomplishing these larger objectives. Moreover, any given practice or curriculum will be one among many that organizations deploy to improve outcomes. As such, a key task of leaders is to support coordination among strategies, so that they yield coherent guidance to educators about what and how to teach (Forman, Stosich, & Bocala, 2017; Jackson & Cobb, 2013; Linn, Kali, Davis, &

Horwitz, 2008). Without such coordination, educators are left to make sense of conflicting guidance on their own, often leading to unintended interpretations of policy (Coburn, 2001), disappointing and inequitable student outcomes (Newmann, Smith, Allensworth, & Bryk, 2001), and teacher burnout (Bryk, Gomez, Grunow, & LeMahieu, 2015).

In a partnership—where concerns related to practice are centered—the focus on outcomes necessitates a shift in how we think about the goals of co-design. It is not sufficient to ask how to sustain a particular innovation, and nor is it adequate to think about how co-design can support many individual teachers' learning. Rather, we have to consider how the process and products of co-design build capacity in the partnership for bringing about educational change (Penuel, 2017). This is a shift away from viewing curriculum as a cause of student learning or support for individual teacher change, as is typical within education research. Further, it invites us to ask questions about what capacities are needed and how co-design fits within a broad range of strategies for building capacity. Finally, in framing the target of capacity-building as the partnership itself—rather than the educational organization—we position ourselves as researchers not in a position of knowing what is best for teachers and education leaders, but as co-learners who must grow with and alongside our partners.

For many partnerships—including our own—equity is a central concern, and foregrounding equity necessitates a further refinement of the goals of co-design. Where some scholars foreground the value of co-design in promoting the usability and sustainability of particular innovations (e.g., Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000), we foreground the goal of *democratizing innovation,* that is, to expand authority in design to a multiplicity of voices in the struggle to define the aims and means of education (Björgvinsson, Ehn, & Hillgren, 2010). In the context of our research practice-partnership, the goal of democratizing innovation means that we are continuously seeking to expand opportunities to participate in shaping the goals and strategies of reform to include a wide range of stakeholders who are not typically at the table during the design process, such as parents, students, and family members. We also mean foregrounding the concerns of these stakeholders in the products we create and taking into consideration how the design process must be structured to include and heed their voices (Penuel, 2014). Co-design, in such situations, inevitably entails some *repair* of inequitable social relations, not just the building of a new curriculum or application (Booker & Goldman, 2016; Ishimaru & Takahashi, 2017).

This latter goal of democratizing innovation puts us squarely within the traditions of participatory design that are well-developed in Scandinavia (Björgvinsson, Ehn, & Hillgren, 2012a, 2012b) and are emerging within the learning sciences community (Bang & Vossoughi, 2016; DiSalvo, Yip, Bonsignore, & DiSalvo, 2017). This is important, because it gives us a language for describing what we are doing when we co-design (e.g., Hillgren, Seravalli, & Emilson, 2011) and a set of values that link us to commitments to social and economic democracy (Ehn, 1992). It also makes demands of us to attend carefully to questions of "Who designs?" and to how power and privilege can undermine efforts to transform inequity through co-design (Esmonde & Booker, 2017; Mendoza, Kirshner, & Gutiérrez, 2018).

Co-design as Infrastructuring with Attention to Power

One of the terms from participatory design we find useful in our partnership to characterize the work we do is *infrastructuring*. The term's origins trace partly back to the insights of Leigh Star (2010) related to why some workplace technologies are not reliably taken up, even if users find them in principle both useful and usable: users do "not know how to *make a reliable working infrastructure* out of it" (p. 610, emphasis added). By that Leigh meant that users could not integrate it into their work in such a way that it met their goals while also becoming invisible to them as a distinct tool, like most good infrastructure is. To say that a goal of co-design is to infrastructure is to assert that a goal must be to create innovations that fit seamlessly within their work context and support users in making a reliable working infrastructure of those innovations. "Fitting seamlessly" in an educational context rife with inequities of resources and opportunities to learn doesn't mean "works under routine conditions of schools", however, as is the goal of researchers seeking to demonstrate educational effectiveness of particular innovations (cf., Institute of Education Sciences & National Science Foundation, 2013). Rather, infrastructuring efforts demand that we also re-design educational infrastructures that influence implementation to be more equitable (Penuel, 2015). When we "design across levels" in this way, we are engaged in a special kind of design research my colleagues and I call Design-Based Implementation Research (DBIR; Fishman, Penuel, Allen, Cheng, & Sabelli, 2013), so named because we are concerned with developing knowledge, tools, and practices related to equitable implementation of innovations and the capacity of partnerships to improve outcomes through inclusive research and development processes.

What are some of the elements and processes that make up educational infrastructures that we target in DBIR projects? Some elements identified in policy research include:

- Standards for student learning,
- Curricular materials,
- Student assessments,
- Teacher professional development,
- Instructional techniques and routines (e.g., for promoting productive talk in classrooms),
- Building and district level policies (e.g., regarding posting of standards, submission of lesson plans that follow a particular format),
- School schedules that allocate instructional time for different subjects,
- Roles and positions focused on instructional support (e.g., coaches),

- Organizational routines, such as grade level meetings, where instruction is a focus, and
- Personnel evaluation systems, including the forms of evidence that contribute to assessment of a teacher's performance (Cohen, Peurach, Glazer, Gates, & Goldin, 2013; Hopkins & Spillane, 2015; Peurach & Neumerski, 2015; Smith & O'Day, 1991; Spillane, Parise, & Sherer, 2011; Woulfin, 2015).

Some of the processes that bring these different components into being and into relation to one another are leaders' "sensegiving" (Gioia & Chittipeddi, 1991) activities meant to help teachers navigate the multitude of conflicting messages that teachers face every day about what and how to teach (Coburn & Woulfin, 2012), routines such as grade-level and department meetings (Coburn, 2001; Spillane et al., 2011), professional development activities intended to help teachers make a working infrastructure of district-led or external initiatives (Johnson, Severance, Penuel, & Leary, 2016). Schools and districts sometimes even convene groups and re-organize systems that are focused specifically on increasing the coherence of the existing infrastructure (Elmore & Burney, 1997; Kirp, 2013).

All of these activities take place within hierarchical and interlocking systems, which have been described as "heterarchies" (Stephenson, 2009) because the networks that connect people and policies often span different levels. The policies and programs that make up a system reflect the past efforts of those with power to set direction for school districts, and rather than being replaced, infrastructures—like the decisions that led to their development in the first place—tend to accrete (Power, 2015). Infrastructure reifies categories—of goals (e.g., "standards"), of strategies (e.g., "evidence-based practice"), and of persons (e.g., "students with disabilities")—in ways that structure social relations and that produce "residuals," that is, situations and even people who do not fit into the categories and that require organizational actors to confront (Bowker & Star, 1999). Attending to power in infrastructuring requires a kind of analytic act of "inversion" to make visible infrastructures and reconstruct the history of their development, to name who benefited and who suffered from the use of particular categories, and to make transparent and more democratic processes for re-design of infrastructure (Bowker & Star).

Infrastructuring in the Inquiry Hub Research-Practice Partnership

Below, I briefly describe two examples of how co-design has supported the goals of capacity building and democratizing innovation in the Inquiry Hub, an ongoing, 11-year old research-practice partnership between the University of Colorado Boulder and Denver Public Schools. The two activities involve more than just the university and district as partners. They also involve other universities and nonprofit research centers, as well as community organizations. I have chosen these examples, because the initial line of work that spawned these infrastructuring efforts was a curriculum co-design effort focused on developing and testing a year-long biology curriculum. Like some of the initiatives described here, co-design started out as a bottom-up strategy to achieve externally defined goals for learning—that is, a new set of standards for science called the Next Generation Science Standards (NGSS; NGSS Lead States, 2013). Over the course of 4 years of design research, we developed both materials and a set of routines for the co-design of problem- and project-based units that are connected to students' interests. Details about the curriculum units and the collaborative design process used to develop and test them are presented elsewhere (Penuel et al., 2018; Severance, Penuel, Sumner, & Leary, 2016). Here, I focus on other co-design efforts that emerged as necessary to support the implementation of the units.

Co-design of Assessments of Student Learning

From the very first iteration of our first unit on ecosystems, teachers raised concerns that the units we had designed together had too few opportunities for assessing student learning. At first, I was puzzled by this concern, because the units included many opportunities for students to express their thinking in small group and whole group discussion, as well as in writing. A final project plan for choosing a tree to plant in each participating classroom's schoolyard required students to show what they had learned about ecosystem dynamics. What more, we wondered, might teachers need?

As the co-design team comprised of teachers, researchers, and district leaders dug deeper, we discovered a number of issues related to assessment that we would need to address—both of students and of the teachers themselves. For example, the district had end-of-unit tests that were not well aligned to the new unit that teachers were required both to administer and score. In addition, early in our design process, the district initiated a new set of procedures and tools for teachers to use to document student growth in their classrooms, as part of their own evaluation, known in Denver elsewhere as Student Learning Objectives (Crouse, Gitomer, & Joyce, 2016). What's more, teachers reported to us their principals each had different requirements for grades and grading; at least one was required to have assignments and grades posted to a learning management system that restricted the kinds of questions that teachers could ask to multiple-choice formats.

While it would be impossible for our small co-design team to tackle all of these challenges at once, we began a series of what participatory designers call "patchwork efforts" (Emilson, Hillgren, & Seravalli, 2014) to support implementation. The unifying goal of these efforts was to a coherent guidance infrastructure for teachers, so that they could feel free to test out new curriculum that did not yet fit neatly within the layered infrastructure that already existed for them.

Though initially—to fit within the time constraints of district processes—members of the research team undertook these efforts ourselves, we realized we needed to create small co-design teams focused on building tools that could become part of the district's instructional guidance infrastructure. A particularly successful effort related to assessment was the development of a rubric that teachers could use to analyze student work products from the curriculum that they could include as part of a portfolio of evidence that their students had met their Student Learning Objectives. The effort was successful, because it demonstrated how by implementing a lesson and grading student work, teachers could produce evidence that would have legitimacy in the eyes of the district with respect to demonstrating their own effectiveness as teachers.

A longer-term effort has focused on building capacity district wide for the development of so-called "three-dimensional assessments," that is, assessments of student learning that measure students' integrated understanding of disciplinary core ideas, science and engineering practices, and crosscutting concepts. Such assessments are difficult to develop and quite distinct from typical multiple-choice tests (National Research Council, 2014; Pellegrino, 2013). Here, our team has undertaken a multi-pronged strategy, involving both direct writing of assessments that could be included on district tests and structured professional development for teacher teams that write these district tests. The long-term aim is to integrate multi-component performance tasks into district tests that are written by teachers who have a deep understanding of how to develop such tasks. Though today many district tests do include such tasks, the effort to transform district tests is an ongoing patchwork effort.

Both of these efforts illustrate co-design as strategies for democratizing innovation and building collective capacity. Teachers were involved not just as co-designers of curriculum materials but as co-designers of components of district infrastructure related to assessment. In so doing, they gained a say in shaping the tools that supervisors at the school and district levels would use to evaluate teaching effectiveness. Through participation in professional development followed by design of assessments, they further contributed to the infrastructure, and the district gained a new capacity for writing assessment tasks that were better aligned to the new vision of science proficiency reflected in the Next Generation Science Standards.

Co-designing with Youth to Develop more Inclusive Classroom Cultures

One of the most persistent asymmetries in classrooms is the authority of teachers relative to students (Apple, 1982; Buzzelli & Johnston, 2001; Oyler, 1995). Teachers have both the power to direct activity within the classroom and to establish what counts as knowledge that students must master (Gore, 1995). In science education, the second kind of authority is problematic for helping students develop an appreciation for the uncertainty of scientific knowledge and its development (Aguiar, Mortimer, & Scott, 2010). Indeed, learning sciences research has underscored that productive disciplinary engagement requires students develop authority for constructing, developing, and critiquing knowledge claims in the classroom (Engle, 2012). Sharing authority among students and teachers for knowledge development can also further democratic ideals of dialogue and deliberation, through disciplinary learning (Michaels, O'Connor, & Resnick, 2008).

In the early years of research on our new curriculum materials, we discovered many different ways that power and authority relations in classrooms served not only as an obstacle to curriculum implementation but also to teachers taking time to learn about their students' ideas, interests and experiences. We discovered this both through informal observations and through the use of a kind of "practical measure" (Yeager, Bryk, Muhich, Hausman, & Morales, 2013) that captured student experiences in classrooms. This measure elicited students' perceptions of the coherence and relevance of a given day's lesson to them and to their communities. In studies of multiple classrooms where we used this measure, we found wide variation across classrooms in students' perceptions of coherence and relevance (Penuel, Van Horne, Severance, Quigley, & Sumner, 2016). These were supported by observations in which we saw teachers engaged in a lot of "telling" students the science ideas within the curriculum, even though the curriculum afforded many different avenues to help students construct their own understandings through guided inquiry into natural phenomena.

As a co-design team comprised of select teachers, district leaders, and researchers, we decided that professional development in the curriculum was not sufficient to accomplish the shifts in authority needed or create classrooms where teachers attended closely to students' ideas and questions. We added to our partnership additional team members from Northwestern University (Reiser, Novak, & McGill, 2017) and the Next Generation Exemplar System (Reiser, Michaels, et al., 2017) and shifted our efforts in the past year to designing professional development for teachers that focused on building an inclusive classroom culture of "figuring out the science ideas together," and we highlighted the kind of talk moves and formats (Michaels & O'Connor, 2011) that could promote student sensemaking and deliberative dialogue among students and teachers about science ideas.

We realized, too, that to change classrooms to be places where students' ideas and questions had more of a say would require the direct involvement of students in our co-design efforts. Where we had not engaged students as co-designers in the past, we formed a new partnership with a community-based youth organization in Denver, Project Voyce, that works in partnership with schools to develop youth-led professional development related to creating respectful, inclusive classrooms. The work that a small co-design team comprised of students, teachers, researchers, and representatives from Project Voyce is now undertaking is the development of protocols that teachers and students in classrooms can follow to ensure that students' perceptions of the coherence and relevance of classroom activities cannot be predicted by their race, their gender, or their home language.

This particular infrastructuring effort represents our recent efforts to attend carefully to issues of power and authority between students and teachers. In this effort, we have kept the science context focal – mindful of the ways that scientific communities share (not always equitably) authority for developing knowledge claims and critiquing knowledge claims of others. And, we have extended our co-design practice so that students have more of a say in some of the classroom routines used with our curriculum—at least in those classrooms where teacher volunteers have begun to take up this work. As with the first infrastructuring effort described above, this effort is ongoing—as nearly every infrastructuring effort in a large system and within a research-practice partnership is—and does not reach every student in the district. We have a long way to go to accomplish our aims of democratizing innovation and building capacity.

Making Co-design More Reliable: A Principled Approach

From the outside—and certainly from a traditional linear model of research and development—our approach might seem reactive and unprincipled. But our partnership is guided by a set of principles that we follow as practitioners of Design-Based Implementation Research (DBIR; Fishman et al., 2013). These principles might also help the next generation of co-design projects become more reliable, in terms of their outcomes. Already, a number of the chapters illustrate these principles in action, even if not all together or in ways that are explicit within the chapters. I close with a description of the principles and an explanation of how infrastructuring efforts like our own can embody them.

Principle 1: Research is focused on addressing shared goals to address persistent problems of practice from multiple stakeholders' points of view. The emphasis on shared goals here highlights the central importance of working in partnership—not just with educators, but all those who have a stake in a focal problem. In the infrastructuring efforts described above, we describe co-design that includes researchers, district leaders, teachers, youth, and community-based organization. In DBIR, the focus is on persistent problems—like inequity of opportunity—rather than on problems that a single administrator or policy maker might decide must be addressed tomorrow. Persistent problems hint at systemic inequities and the operation of power in ways that can focus and sharpen DBIR projects. As is richly illustrated in a number of chapters in this volume, this principle can be embodied by study of the problems and the contexts where work will take place.

Principle 2: Commitment to collaborative, iterative design. Co-design is an essential feature of DBIR projects, and it is framed as a commitment that can yield not only more usable designs but also helps to realize the goal of democratizing innovation. Though sometimes we fail in this commitment in our own work when we engage in patchwork efforts to support implementation, we are reminded always that when we want to develop capacity as a partnership in a particular area, we need to establish a co-design team. This volume is a testament to the multitude of benefits that come from co-designing with teachers and non-governmental organizations; even more is possible when we broaden who designs to encompass students and community members and parents (Bang, Medin, Washinawatok, & Chapman, 2010; Barajas-López & Ishimaru, in press).

Principle 3: Developing knowledge, tools, and practices related both to classroom learning and implementation. DBIR always has at least two layers of theory and is involved in design across levels or settings in educational settings. One layer of theory pertains to classroom (or out of school) learning, and this theory guides design for student or youth learning. Another layer guides our change efforts—it might be a theory of teacher learning such as guides many of the efforts described in this volume, or a theory of organizational change, as also guides some efforts presented here. In our own work, theories of productive disciplinary engagement support design of interventions to create inclusive classroom cultures, and theories related to the role that educational infrastructures play in informing teacher decision making guide precisely *where* we decide to spend time and effort. Our "reactivity" in addressing issues related to assessment, for example, is not so reactive as it is acting in ways that assume some regularities across educational infrastructure exist in how they influence teaching. Both the infrastructure and patterns of influence have become focal points of co-design; different ones will emerge as important if our partnership continues to evolve.

Principle 4: Building capacity for continuous change within a research-practice partnership. Capacity here is how we have described it in our efforts—as the collective capabilities of a group of co-designers to create, test, and refine designs using evidence from implementation. This principle emphasizes the continuous nature of these cycles, in ways that align with contemporary movements in education related to improvement science (Bryk et al., 2015). We emphasize this capacity as one of a partnership—rather than of a research or educational organization—because the commitment in partnerships is open-ended. Unlike the traditional research and development models where there is an expected "transfer of ownership," ownership is baked into the processes of partnership development and routines of co-design. And while partners must still work to build ownership among those who have not been involved in the design process, this challenge is a shared challenge taken on by the partnership.

I believe the application of these principles can guide co-design in education in the future to new successes. The conditions identified for successful co-design in this book give us some important targets of focus, such as on building collective capabilities for design and on organizational change, in particular. We just need to ask ourselves what infrastructures exist in the contexts where we are working for developing capability and for supporting change and then begin to re-design them together.

References

Aguiar, O. G., Mortimer, E., & Scott, P. (2010). Learning from and responding to students' questions: The authoritative and dialogic tension. *Journal of Research in Science Teaching, 47*(2), 174–193.

Apple, M. (1982). *Education and power*. Boston: Routledge.

Bang, M., Medin, D., Washinawatok, K., & Chapman, S. (2010). Innovations in culturally based science education through partnerships and community. In M. S. Khine & M. I. Saleh (Eds.), *New science of learning: Cognition, computers, and collaboration in education* (pp. 569–592). New York: Springer.

Bang, M., & Vossoughi, S. (2016). Participatory design research and educational justice: Studying learning and relations within social change making. *Cognition and Instruction, 34*(3), 173–193.

Barajas-López, F., & Ishimaru, A.M. (in press). "Darles el lugar": A place for nondominant family knowing in educational equity. *Urban Education*. https://journals.sagepub.com/doi/full/10.1177/0042085916652179

Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2010). *Participatory design and democratizing innovation.* Paper presented at the Proceedings of the 11th Biennial Participatory Design Conference.

Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2012a). Agonistic participatory design: Working with marginalised social movements. *CoDesign, 8*(2–3), 127–144.

Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2012b). Design things and design thinking: Contemporary participatory design challenges. *Design Issues, 28*(3), 101–117.

Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist, 35*(3), 149–164.

Booker, A., & Goldman, S. V. (2016). Participatory design research as a practice for systemic repair: Doing hand-in-hand math research with families. *Cognition and Instruction, 34*(3), 223–235.

Bowker, G., & Star, S. L. (1999). *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.

Bryk, A. S., Gomez, L. M., Grunow, A., & LeMahieu, P. G. (2015). *Learning to improve: How America's schools can get better at getting better*. Cambridge, MA: Harvard University Press.

Buzzelli, C., & Johnston, B. (2001). Authority, power, and morality in classroom discourse. *Teaching and Teacher Education, 17*(8), 873–884.

Coburn, C. E. (2001). Collective sensemaking about reading: How teachers mediate reading policy in their professional communities. *Educational Evaluation and Policy Analysis, 23*(2), 145–170.

Coburn, C. E., & Penuel, W. R. (2016). Research-practice partnerships in education: Outcomes, dynamics, and open questions. *Educational Researcher, 45*(1), 48–54.

Coburn, C. E., & Woulfin, S. L. (2012). Reading coaches and the relationship between policy and practice. *Reading Research Quarterly, 47*(1), 5–30.

Cohen, D. K., Peurach, D. J., Glazer, J. L., Gates, K., & Goldin, S. (2013). *Improvement by design: The promise of better schools*. Chicago: University of Chicago Press.

Crouse, K., Gitomer, D. H., & Joyce, J. (2016). An analysis of the meaning and use of student learning objectives. In K. K. Hewitt & A. Amrein-Beardsley (Eds.), *Student growth measures in policy and practice* (pp. 203–222). New York: Macmillan.

DiSalvo, B., Yip, J., Bonsignore, E., & DiSalvo, C. (Eds.). (2017). *Participatory design for learning: Perspectives from practice and research*. New York: Routledge.

Donovan, M. S. (2013). Generating improvement through research and development in educational systems. *Science, 340*, 317–319.

Ehn, P. (1992). Scandinavian design: On participation and skill. In P. S. Adler & T. A. Winograd (Eds.), *Usability: Turning technologies into tools* (pp. 96–132). New York: Oxford University Press.

Elmore, R. F., & Burney, D. (1997). *Investing in teacher learning: Staff development and instructional improvement in community School District #2*. New York: National Commission on Teaching and America's Future.

Emilson, A., Hillgren, P.-A., & Seravalli, A. (2014). Designing in the neighborhood: Beyond (and in the shadow of) creative communities. In P. Ehn, E. M. Nilsson, & R. Topgaard (Eds.), *Making futures: Marginal notes on innovation, design, and democracy* (pp. 35–62). Cambridge, MA: MIT Press.

Engle, R. A. (2012). The productive disciplinary engagement framework: Origins, key concepts, and developments. In Y. Dai (Ed.), *Design research on learning and thinking in educational settings: Enhancing intellectual growth and functioning* (pp. 161–200). New York: Routledge.

Esmonde, I., & Booker, A. N. (2017). *Power and privilege in the learning sciences: Critical and sociocultural perspectives*. New York: Routledge.

Fishman, B.J., Penuel, W.R., Allen, A.-R., Cheng, B.H., Sabelli, N. (2013). Design-based implementation research: An emerging model for transforming the relationship of research and practice. In B. J. Fishman, W. R. Penuel, A.-R. Allen, & B. H. Cheng (Eds.), *Design-based implementation research. National Society for the Study of Education Yearbook, 112*(2), 136–156.

Fishman, B. J., Penuel, W. R., Hegedus, S., & Roschelle, J. (2011). What happens when the research ends? Factors related to the sustainability of a technology-infused mathematics curriculum. *Journal of Computers in Mathematics and Science Teaching, 30*(4), 329–353.

Forman, M. L., Stosich, E. L., & Bocala, C. (2017). *The internal coherence framework: Creating the conditions for continuous improvement in schools*. Cambridge, MA: Harvard Educational Press.

Frumin, K. (2018). *Researchers and practitioners in partnership: Co-design of a high school biology curriculum.* Unpublished doctoral dissertation. Cambridge, MA: Harvard Graduate School of Education.

Gioia, D. A., & Chittipeddi, K. (1991). Sensemaking and sensegiving in strategic change initiation. *Strategic Management Journal, 12*(6), 433–448.

Gore, J. M. (1995). On the continuity of power relations in pedagogy. *International Studies in Sociology of Education, 5*(2), 165–188.

Henrick, E. C., Cobb, P., Penuel, W. R., Jackson, K., & Clark, T. R. (2017). *Assessing research-practice partnerships: Five dimensions of effectiveness*. New York: William T. Grant Foundation.

Hillgren, P.-A., Seravalli, A., & Emilson, A. (2011). Prototyping and infrastructuring in design for social innovation. *CoDesign, 7*(3–4), 169–183.

Hopkins, M., & Spillane, J. P. (2015). Conceptualizing relations between instructional guidance infrastructure (IGI) and teachers' beliefs about mathematics instruction: Regulative, normative, and cultural-cognitive considerations. *Journal of Educational Change, 16*(4), 431–450.

Institute of Education Sciences, & National Science Foundation. (2013). *Common guidelines for education research and development*. Washington, DC: Institute of Education Sciences, & National Science Foundation.

Ishimaru, A. M., & Takahashi, S. (2017). Disrupting racialized institutional scripts: Toward parent-teacher transformative agency for educational justice. *Peabody Journal of Education, 92*(3), 343–362.

Jackson, K., & Cobb, P. (2013). Coordinating professional development across contexts and role group. In M. Evans (Ed.), *Teacher education and pedagogy: Theory, policy and practice* (pp. 80–99). New York: Cambridge University Press.

Johnson, R., Severance, S., Penuel, W. R., & Leary, H. A. (2016). Teachers, tasks, and tensions: Lessons from a research-practice partnership. *Journal of Mathematics Teacher Education, 19*(2), 169–185.

Kirp, D. L. (2013). *Improbable scholars: The rebirth of a great American school system and a strategy for America's schools*. New York: Oxford University Press.

Linn, M. C., Kali, Y., Davis, E. A., & Horwitz, P. (2008). Policies to promote coherence. In Y. Kali, M. C. Linn, & J. E. Roseman (Eds.), *Designing coherent science education* (pp. 201–210). New York: Teachers College Press.

Mendoza, E., Kirshner, B., & Gutiérrez, K. D. (Eds.). (2018). *Power, equity and (re)design: Bridging learning and critical theories in learning ecologies for youth*. Charlotte, NC: Information Age Publishing.

Michaels, S., O'Connor, C., & Resnick, L. B. (2008). Deliberative discourse idealized and realized: Accountable talk in the classroom and in civic life. *Studies in the Philosophy of Education, 27*, 283–297.

Michaels, S., & O'Connor, M. C. (2011). *Talk science primer*. Cambridge, MA: TERC.

National Research Council. (2014). *Developing assessments for the next generation science standards*. Washington, DC: National Academies Press.

Newmann, F. M., Smith, B., Allensworth, E., & Bryk, A. S. (2001). Instructional program coherence: What it is and why it should guide school improvement policy. *Educational Evaluation and Policy Analysis, 23*(4), 297–321.

NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: National Academies Press.

Oyler, C. (1995). *Making room for students: Sharing teacher authority in room 104*. New York: Teachers College Press.

Pellegrino, J. W. (2013). Proficiency in science: Assessment challenges and opportunities. *Science, 340*, 320–323.

Penuel, W. R. (2014). Emerging forms of formative intervention research in education. *Mind, Culture, and Activity, 21*(2), 97–117.

Penuel, W. R. (2015). *'Infrastructuring' as a practice for promoting equity and transformation in design-based implementation research*. Paper presented at the International Society for Design and Development in Education (ISDDE) 15, Boulder, CO.

Penuel, W. R. (2017). *Building capacity through developing and supporting new curriculum materials in a research-practice partnership.* Invited presentation to the Center for Science Teaching and Learning at Northern Arizona University. Boulder, CO: University of Colorado Boulder.

Penuel, W. R., Coburn, C. E., & Gallagher, D. (2013). Negotiating problems of practice in research-practice partnerships focused on design. In B. J. Fishman, W. R. Penuel, A.-R. Allen, & B. H. Cheng (Eds.), *Design-based implementation research: Theories, methods, and exemplars. National society for the study of education yearbook* (pp. 237–255). New York: Teachers College Record.

Penuel, W. R., & Gallagher, D. (2017). *Creating research-practice partnerships in education*. Cambridge, MA: Harvard Education Press.

Penuel, W.R., Reiser, B.J., Novak, M., McGill, T., Frumin, K., Van Horne, K. et al. (2018). *Using co-design to test and refine a model for three-dimensional science curriculum that connects to students' interests and experiences*. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.

Penuel, W. R., Roschelle, J., & Shechtman, N. (2007). Designing formative assessment software with teachers: An analysis of the co-design process. *Research and Practice in Technology Enhanced Learning, 2*(1), 51–74.

Penuel, W. R., Van Horne, K., Severance, S., Quigley, D., & Sumner, T. (2016). Students' responses to curricular activities as indicator of coherence in project-based science. In C.-K. Looi, J. L. Polman, U. Cress, & P. Reimann (Eds.), *Proceedings of the 12th international conference of the learning sciences* (Vol. 2, pp. 855–858). Singapore: International Society of the Learning Sciences.

Peurach, D. J., & Neumerski, C. M. (2015). Mixing metaphors: Building infrastructure for large scale school turnaround. *Journal of Educational Change, 16*(4), 379–420.

Power, M. (2015). How accounting begins: Object formation and the accretion of infrastructure. *Accounting, Organizations and Society, 47*, 43–55.

Reiser, B.J., Michaels, S., Moon, J., Bell, T., Dyer, E., Edwards, K.D., et al. (2017). Scaling up three-dimensional science learning through teacher-led study groups across a state. *Journal of Teacher Education, 68*(3), 280–298.

Reiser, B. J., Novak, M., & McGill, T. A. W. (2017). *Coherence from the students' perspective: Why the vision of the framework for K-12 Science Education requires more than simply "combining three dimensions of science learning"*. Paper presented at the Board on Science Education Workshop "Instructional Materials for the Next Generation Science Standards, Washington, DC.

Severance, S., Penuel, W. R., Sumner, T., & Leary, H. (2016). Organizing for teacher agency in curriculum design. *Journal of the Learning Sciences, 25*(4), 531–564.

Smith, M., & O'Day, J. A. (1991). Systemic school reform. In S. H. Fuhrman & B. Malen (Eds.), *The politics of curriculum and testing* (pp. 233–268). Bristol, PA: Falmer.

Spillane, J. P., Parise, L. M., & Sherer, J. Z. (2011). Organizational routines as coupling mechanisms: Policy, school administration, and the technical core. *American Educational Research Journal, 48*(3), 586–619.

Star, S. L. (2010). This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, and Human Values, 35*, 601–617.

Stephenson, K. (2009). Neither hierarchy nor network: An argument for heterarchy. *People and Strategy, 32*(1), 4–7.

Woulfin, S. L. (2015). Highway to reform: The coupling of district reading policy and instructional practice. *Journal of Educational Change, 16*(4), 535–557.

Yeager, D., Bryk, A. S., Muhich, J., Hausman, H., & Morales, L. (2013). *Practical measurement*. Stanford, CA: Carnegie Foundation for the Advancement of Teaching.

Chapter 22
Developing the Human, Material, and Structural Aspects of Infrastructure for Collaborative Curriculum Design: Lessons Learned

Susan McKenney

Introduction

During collaborative curriculum design (CCD), two objectives are typically pursued: curriculum innovation and teacher learning. In CCD, teams of educators typically work together to create curricular resources that can be used in everyday classroom settings. Sometimes teams create tools to be used only by themselves, but often they create materials for use by (themselves and) others. Generally, the curricula developed through CCD embody reform aspirations that are intended to enrich learner experiences or outcomes. Engaging in this process requires teachers to reflect on their own practice, challenge assumptions, share expertise, and negotiate meaning with regard to how to meet the needs of learners (Kali, McKenney, & Sagy, 2015). As such, these processes form robust and viable sources of teacher professional development.

The interdependence between curriculum design and teacher learning has been well clarified in the introductory chapter of this book (Voogt, Pieters, & Pareja Roblin, this volume), as well as for decades in the literature (e.g., Ben-Peretz, 1990; Stenhouse, 1980). Additionally, there is little dispute that pursuing the twin goals of curriculum innovation and teacher learning can be synergistic, especially when undertaken through the workings of CCD. The increasing recognition of these synergies has been demonstrated through multiple individual studies (e.g., Boschman, McKenney, & Voogt, 2014; Cviko, McKenney, & Voogt, 2014; Koehler & Mishra, 2005) and a special issue of *Instructional Science* on teachers as designers of technology-enhanced learning (volume 43, 2015), as well as the chapters throughout this book. Alongside recognition of these synergies, research has also

S. McKenney (✉)
Faculty of Behavioral, Management and Social Sciences, University of Twente, Enschede, The Netherlands
e-mail: susan.mckenney@utwente.nl

J. Pieters et al. (eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, https://doi.org/10.1007/978-3-030-20062-6_22

demonstrated that high quality support is crucial for success (Binkhorst, Poortman, McKenney, & van Joolingen, 2018; Kali & Ronen-Fuhrmann, 2011).

The fact that curriculum innovation and teacher learning can be mutually beneficial does not mean that each of these processes requires the same support. In fact, each of these processes is complex and notoriously challenging. So, despite their synergies and natural interdependencies, combining the goal of curriculum innovation with the goal of teacher learning is extremely ambitious. Thus, to support CCD work well, it seems prudent to *explore whether and how the support needed for curriculum innovation aligns with that needed for teacher learning, and vice versa*. Additionally, it would be useful to identify any potential trade-offs or tensions between the respective forms of support required to achieve curriculum innovation and teacher learning. Toward this aim, the following section presents a lens through which to examine the supportive contexts of CCD.

Infrastructure for Collaborative Curriculum Design

CCD Is Situated

CCD does not take place in a vacuum, but within the dynamic and complex reality of educational settings. This means that the environments for CCD have crucial influence on CCD processes and on whether and how CCD processes yield the desired outcomes. Along with challenges, this situativity also holds opportunities for CCD. For example, curriculum innovation that is conceived in light of teacher daily practice stands a better chance of being implemented, because it takes into consideration the status quo, as well as the barriers and enablers present, in ways that help target incremental innovation toward what teachers and schools can implement with sustainable amounts of guidance or collaboration (McKenney, 2013). Similarly, research on teacher professional development has long stressed the need for teacher learning opportunities to be situated not outside of, but rather within the demands of daily practice (Van Veen, Zwart, Meirink, & Verloop, 2010).

While many contextual factors play a role in the work of teachers, three wield particularly powerful influence on how they think, feel and act, both inside and outside of the classroom. These are the: human, material, and structural aspects of context. While these aspects play a crucial role in the daily experience of teachers, it is important to note that they are not always experienced as positive. For example, human expertise may be unwelcome when foisted upon teachers who do not recognize a need for it; materials that are poorly aligned with the curriculum may create extra burdens for teachers; or inconsistent policies may force teachers into conflicting roles. On the other hand, many other aspects are productive, such as: high quality coaches whose expertise is welcome; materials that increase teacher effectiveness or efficiency; or policies that enable teachers to access the expertise they need when they need it. The human, material, and structural aspects of context that make productive contributions to the work of teachers (and in this case, specifically, their CCD), are referred to here as *infrastructure*.

Infrastructure

Human aspects of infrastructure that influence the work of teachers include interactions with colleagues and experts, but especially with learners. Implicitly and explicitly, learners regularly provide teachers with knowledge about the consequences of their actions, which plays a crucial role in their professional development (Clarke & Hollingsworth, 2002). Research in the learning sciences has emphasized the role that others play in the development of an individual's knowledge (Resnick, Levine, & Teasley, 1991), and this definitely includes the learning of teachers (Borko, 2004). As is typical for workplace learning, teachers learn from the discourse and habits of communities that share the goal of fostering learner understanding and development (Brown & Duguid, 1991; Cobb, 1994; Hord, 2009; Lave & Wenger, 1991; Van Veen et al., 2010). Conversation, and to a lesser extent, writing are the most important activities through which members of teacher communities engage with one another (Avalos, 2011; Cochran-Smith & Lytle, 2001). Conversation offers teachers essential opportunities to share knowledge, discuss what they want to learn, and become exposed to new concepts and strategies that meet the needs of their own contexts (Darling-Hammond & McLaughlin, 1995). At the same time, research has also shown that rich opportunities to learn through teacher talk are more commonly the exception rather than the rule. This is the case with general teacher work groups (Horn, Garner, Kane, & Brasel, 2016) as well as with teacher design teams (Boschman, McKenney, Pieters, & Voogt, 2016; Boschman, McKenney, & Voogt, 2015). In addition, given that high quality conversation depends on the skills required to identify and frame problems (and given that these skills are characteristic of particularly talented professionals), it is the competent teacher who mostly stands to gain from learning through conversations with colleagues (Horn & Kane, 2015). These insights point to the crucial roles to be played by leadership (Binkhorst et al., 2018), new expertise (Hord, 2009; Van Veen et al., 2010), and a culture that stimulates exploration of arguments, plausible explanations, and new approaches (Ball & Cohen, 1999).

Material aspects of infrastructure that shape teacher work include digital and analogue resources designed for individual or group use, inside or outside of the learning environment. Important tools for teachers can include those which are intended for use by the teachers themselves (such as teacher guides or computer-based planning applications) or by their learners (such as simulations or worksheets) (Putnam & Borko, 2000). There is little doubt that lesson materials offer crucial support to all teachers, and especially to beginning teachers (Grossman & Thompson, 2008). They can serve as vehicles for instructional improvement (Ball & Cohen, 1996), especially when they attend not only to the needs of the learners, but also to the needs of teachers (Pareja Roblin, Schunn, & McKenney, 2018). The characteristics of educative materials – resources that support the learning of both students and of teachers – are well described in the literature (Davis & Krajcik, 2005; Drake, Land, & Tyminski, 2014; Remillard, 2000; Remillard, Herbel-Eisenmann, & Lloyd, 2011; Van den Akker, 1998). Alongside other resources, educative materials can support ambitious teaching. Further, ‘priming’ tools help (especially beginning) teachers to unravel concepts and thus to gain insight into how learners can build on prior knowledge derived from everyday experiences or previous lessons (Windschitl, Thompson, Braaten, & Stroupe, 2012).

Structural aspects of infrastructure include policies, norms, and routines that are ensconced in the organizational, local, or national system. For example, Handalzalts, Nieveen, and Van den Akker (this volume) alluded to structural aspects when drawing on a framework (Hargreaves, 2003) for understanding cultures and performance agreements. Policy is perhaps the most powerful structural aspect that can influence the work of teachers. Policy can support productive interactions, by creating the space and time for learning (Coburn & Russell, 2008a; Darling-Hammond & McLaughlin, 1995; Hord, 2009); by stressing that teacher talk should focus on learners (Coburn & Russell, 2008b); by consistently emphasizing that teachers are, individually and collectively, responsible for learner performance; and by ensuring that teacher evaluations are conducted in ways that align with these values (Little, 1999; Van Veen et al., 2010). Policy can enable sustainable change by limiting the number of new initiatives prioritized simultaneously (Coburn & Russell, 2008a); by ensuring the kind of long-term commitment to change that is necessary for innovations to take root in the organizational routines and practice of those involved (Garet, Porter, Desimone, Birman, & Yoon, 2001; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Van Veen et al., 2010); and by supporting a culture that embraces a shared appreciation of improvement science (Dolle, Gomez, Russell, & Bryk, 2013). Finally, through conscious prioritization (e.g., financially), school, local, and national policies can support the initiation and maintenance of productive collaborations (Linn, Gerard, Matuk, & McElhaney, 2016) such as those between schools and researchers (Coburn, Penuel, & Geil, 2013; Lewis, Perry, & Murata, 2006), between individual teachers and content specialists in their school (Diamond & Spillane, 2004; Lee, Penfield, & Maerten-Rivera, 2009), or between schools and those who offer professional development opportunities to teachers (Gerard, Bowyer, & Linn, 2010).

Infrastructuring

It is not only the characteristics of the human, material, and structural aspects of context that play a role in shaping the work of teachers. Often, the processes through which they come to fruition are equally powerful. For example, policies that were created with input from teachers are likely to be more accessible and therefore more understood by other teachers; also, having a voice in policy development can create ownership, which, alongside clarity, also influences how policies are enacted. While some processes can have negative effects on how the human, material, and structural aspects of context are perceived and enacted, this chapter focuses on those that are productive. Specifically, it focuses on the work of *infrastructuring*.

Introduced by Penuel (2015, 2019) infrastructuring is an approach to facilitating the development of both durable change and equity between multiple stakeholders in intervention research. It combines concepts of participatory design (Dantec & DiSalvo, 2013; Star & Ruhleder, 1996) with concepts from educational change research (Hopkins & Spillane, 2015; Hopkins, Spillane, Jakopovic, & Heaton, 2013), and is highly relevant to CCD. As Penuel (this volume) noted, "To say that a goal of co-design is to infrastructure is to assert that a goal must be to create innovations that fit seamlessly within their work context and support users in making a reliable working infrastructure of those innovations." With the goal of supporting the work of infrastructuring in CCD, the following analysis revisits empirical findings from this book related to (developing) the human, material, and structural aspects of infrastructure that were found critical for supporting CCD work.

Key Insights from Previous Chapters

The goal of this section is to harvest key insights on infrastructuring curriculum innovation and teacher learning through CCD from the cases described throughout this book. While the studies described in this book address both curriculum innovation and teacher learning, each tends to foreground one goal over the other. In most cases, this means that they acknowledge, and where possible leverage, the synergies between these two processes for the CCD project work. At the same time, the primary goal of individual studies, and the main focus of data collection and analysis, tends to center on variables related to either curricular innovation or teacher learning. This is common in CCD projects, which are typically granted financial or institutional support through (a derivative of) one of these two basic arguments: (1) "To achieve our goals for *curriculum innovation,* investment in teacher learning is necessary and collaborative design can support both" or (2) "To achieve our goals for *teacher learning*, collaborative design of a curriculum innovation is a practical and effective approach."

This section therefore begins by characterizing the CCD processes and outcomes related to curriculum innovation and teacher learning respectively, based on studies that explicitly researched (the relationship between) CCD processes and CCD outcomes. Then, empirical findings concerning the (development of) human, material, or structural aspects of infrastructure to support CCD are discussed. Each of these is also positioned in light of the synergistic but distinctly different goals of curriculum innovation and teacher learning. NB: In the following paragraphs, key insights are shown in italics.

CCD Processes and Outcomes

Related to Curriculum Innovation

In terms of CCD *processes*, Handelzalts (this volume) found that the activities and experiences to be *highly varied, even in similar reform settings*. He also found that, in general, the process of *design is collaborative but construction is individual*. That is, the teams often showed a pattern in which conceptualization, consideration of options, and mapping of solutions are discussed together, while the actual construction of materials is an individual exercise. Agyei (this volume) concluded that design teams can provide a platform for *interaction and interdependence* among teachers, which can prompt them to share knowledge and ideas. Akomaning (this volume) found that CCD was viewed by the stakeholders as a *bottom-up* approach for developing instructor capacity while also improving learning opportunities for students. Huizinga, Nieveen, and Handelzalts (this volume) examined how teachers in CCD teams whose materials are ripe for dissemination attend to implementation by others who were not engaged in CCD. In their study, the CCD teachers were *sensitive to the needs of others to understand and implement reform*. That is, they anticipated the need to enhance their colleagues' ownership of the materials and initiated various activities to help develop this. These activities included collaborative preparation for classroom implementation, offering exemplary materials, and discussing video recordings of lessons.

In terms of (influencing) CCD *outcomes*, Handelzalts (this volume) showed that having a *clear vision supports productivity*. Specifically, teams with clearer common reform ambitions and positive dispositions toward the reform initiative were better able to jump into designing and rethinking their curriculum. Conversely, teams that started off with a vague reform mission needed (much time) to reach sufficient clarity about organizational conditions before starting to work on their plans. Further, teachers who began the process with little direction (which is often well-intended – to give teams freedom) experienced great difficulty; these groups focused on procedural elements, and regarded practicality as the main quality criterion for their products. In line with this finding, Handelzalts concluded that *structure supports productivity*. His data show that the more structure there is, the more actual construction gets done. Further, it does not seem to matter if the structure is introduced by others (e.g., a collaborator deciding it is time for a meeting), or if it emerges from the group (e.g., the team decides together how to proceed at the end of a meeting), as long as it is present. In their exploration of scientific and colloquial evidence on CCD, Westbroek, de Vries, Walraven, Handelzalts, and McKenney (this volume) found that CCD supported the *alignment of curricular ideals with the perceived and sometimes also the attained curriculum*. These outcomes, however, tended to vary along with the corpus of literature in which they were presented (scientific journals or professional journals). Namely, the professional literature showed effects relating to the alignment of the ideal curriculum going all the way to the attained curriculum, whereas the scientific literature focused on the effects of aligning the ideal and the perceived curriculum. Negative influences on CCD outcomes were also identified in this volume. Bakah, Nihuka and Gendole (this volume) found that CCD may *conflict with an existing culture of collaboration*, which can be a hindrance to a team's ability to function. They also found that CCD may *conflict with existing schedules and responsibilities*. They highlighted the importance of understanding how structural conditions give or take away time for the development of CCD work (e.g., pressuring teachers to obtain higher qualifications outside of the university leaves them very little time for innovation). While indirect measures of curriculum quality were taken into consideration in several studies (e.g., how new users perceive the products of CCD), none of the studies in this volume reported on direct measures of the quality of the curricula developed.

Related to Teacher Learning

Nihuka (this volume) found that the *process* of CCD was characterized by *exchange and validation of expertise*. That is, CCD provided an opportunity for instructors to discuss the challenges of traditional practice, as well as the rationale for and potential of e-learning technologies. This resulted from instructors sharing expertise, acknowledging each other's good ideas, and collaborating with regard to course organization and delivery. In addition, when Huizinga, Nieveen, and Handelzalts (this volume) studied the implementation of CCD products, their classroom observations revealed *highly varied* classroom implementation across teachers both within and between different teams. They found that CCD participants did possess *design expertise, but had limited (analysis or) evaluation knowledge and skills*. That is, the teams rarely conducted evaluation activities on their own and if they did, these were unstructured and very closely related to their regular-day classroom tasks. They also found that the classroom implementation and evaluation processes were affected by teachers' understanding of the reform, their pedagogy, and especially their role in the CCD work.

With regard to CCD *outcomes*, the instructors in Nihuka's study (this volume) *improved their understanding and appreciation of the reform* through CCD, and their resulting course design had a positive impact on both teacher practices and student outcomes. Similarly, several other studies showed that CCD is promising for professional development because it contributed to *improved knowledge and skills* (Alayyar & Fisser, this volume; Bakah, this volume; Gendole & Coenders, this volume), while also generating *ownership of and commitment to* the reform (Alayyar & Fisser, this volume). Finally, as was the case with their investigation of scientific and professional literature on CCD for curriculum innovation, Westbroek, de Vries, Walraven, Handelzalts, and McKenney (this volume) found that the professional development outcomes reported in the literature varied by source type. Namely, they found that the professional literature portrayed CCD effects including experiencing relevance, teambuilding and (resulting from these) *ownership*. The scientific literature they reviewed also showed that teachers experienced relevance and appreciation for their active involvement, but that other specific learning yields were difficult to pinpoint.

Human Aspects of Infrastructure to Support CCD

For Curriculum Innovation

Several studies yielded empirical findings related to the *roles* of participants in CCD. As noted previously, Westbroek, de Vries, Walraven, Handelzalts, and McKenney (this volume) identified differences based on the corpus of literature being examined (scientific or professional). In all cases, they concluded that *(perceived) roles differ, by project and person*, but they also found that teams described in the scientific corpus were primarily researcher-led, with teachers in the role of learners. Conversely, the professional corpus painted a picture in which teams were primarily teacher-led, with teachers serving as experts. In another study, *team characteristics* (and not just the clarity of the initial reform) influenced CCD team functioning (Handalzalts, this volume). Similarly, in their examination of development work informed by research, Pareja Roblin and McKenney (this volume) identified a primary knowledge source informing innovation development: the *expertise of the multidisciplinary team.* Further, they found that university researchers took on the tasks of assessing quality, utility, feasibility or effectiveness; content specialists contributed to the design of the innovation as well as assisting researchers with data collection and advising teachers or students during implementation. The role of teachers was more reactive (giving viewpoints or feedback on the quality or effectiveness of prototypes), but that is not surprising as this study did not focus on co-design, per se.

Several studies pointed to the crucial role of *leadership* for supporting CCD. Albashiry (this volume) found that *curricular leadership* was required for sustained and systematic work. He also identified multiple forms of professional development that are required for curricular leaders, including training, coaching, exemplary materials, handouts, and templates. In addition, *commitment from management* was found to be crucial; for example, teacher enthusiasm was boosted when leaders encouraged the formation of new design teams (Bakah, Nihuka, & Arkato Gendole, this volume). For CCD to succeed, there must be a *leadership style attuned to team needs* (Handelzalts, this volume). For example, when a flexible and emergent reform strategy is used with teams that have a vague reform ambition, a more proactive and involved role is required from management. Finally, for sustained development, it is important to enact *distributed leadership* and *responsibility*, alongside creating a *culture of support* (appreciating successes, being responsive, giving follow-up, asking for it and using feedback from learners and parents) (Handelzalts, Nieveen, & Van den Akker, this volume).

A third dimension of the human aspects of infrastructure emerging from these studies relates to developing *shared understanding and expectations*. Two studies in particular stressed the importance of involving more participants than just teachers in CCD for curriculum development. In one case (Akomaning, this volume), key contributors were not only teachers, but also other *stakeholders*, including those from industry, industrial liaison officers, and students. *Developing shared awareness* was crucial, especially with these other stakeholders. Similarly, Gervedink Nijhuis (this volume) identified the need to *involve local stakeholders* as developers, experts, or instructors as well as to *facilitate local stakeholders* in dealing with transfer and problem-solving conditions that support implementation. Her data revealed the need to *understand the expectancies and preferences of participants*, in terms of tasks, responsibilities, communication strategies, time perceptions, and financial remuneration. They also suggested that the goals of CCD work are best served when participants are willing, open-minded, and culturally sensitive about *appreciating differences.* This may explain why a *blend of systematic and relational approaches* was found to be a major contributor to the internal and external consistency of the resulting curricula in one of the studies (Albashiry, this volume).

For Teacher Learning

For the goal of supporting teacher learning through CCD, data showed that *experts facilitate sharing*, and that this served team functioning. Kafyulilo and Fisser (this volume) reported improvements in teachers' self-reported and observed knowledge related to integrating technology into their science and mathematics teaching. Their findings indicated that this happened by *sharing knowledge, skills, experiences, and challenges,* and this sharing was due to the *expert facilitation* including *substantive expertise* in science and education technology. Similarly, Huizinga, Nieveen, and Handelzalts (this volume) portrayed the crucial role played by *facilitators in supporting reflection* and sharing of experiences. They identified three gaps in teachers' design expertise (curriculum design expertise, pedagogical content knowledge, curricular consistency expertise) and suggested that facilitators must be able to help teachers address these gaps. They stressed that facilitators themselves require a *deep understanding of curriculum design*, including the ability to identify which design approach is most fitting in a given situation. Further, their data indicated that facilitator support styles should be both *proactive and reactive*. The former helps ensure that all important steps are undertaken, and the latter comes more naturally to most CCD teams.

In addition to the role of facilitators, studies also pointed to the importance of *project coordination and management support* for CCD to support teacher learning. In their second chapter, Huizinga, Nieveen, and Handelzalts (this volume) showed why CCD team coordinators require basic *planning and monitoring skills* to manage and lead CCD teams well, and their role in helping foster ownership of CCD outcomes that are to be carried forward in an organization. For similar reasons, Agyei and Kafyulilo (this volume) also stressed the importance of *management support.*

Material Aspects of Infrastructure to Support CCD

For Curriculum Innovation

In these studies, *documents* were the most common form of materials to productively support curriculum innovation though CCD. This included *research literature* as a knowledge source for informing innovation development (Pareja Roblin & McKenney, this volume) as well as *high quality guiding documents,* such as those that helped streamline the implementation described by Akomaning (this volume). *Exemplary curriculum* materials were also mentioned as important sources of inspiration that promote better understanding of the reform (Akomaning, this volume), not only for their practical use, but also because discussion of concrete *plans and products* in which abstract ideas have been made tangible and accessible benefits participant understanding (Handelzalts (this volume).

For Teacher Learning

Documents were also the most frequently mentioned form of material support for teacher learning through CCD. Research showed that external support can be given through *templates and tools* that help teams evaluate and select source materials, for example, or conduct formative evaluation of the CCD products with students (Huizinga, Nieveen, & Handelzalts, this volume). Kafyulilo and Fisser (this volume) attributed improvement of teacher expertise for integrating technology into their science and mathematics teaching to three forms of documents, namely: *collaboration guidelines, exemplary lessons, and* (online) *learning material* (e.g., literature).

Two studies collected data on the role of *digital tools*. In the study by Alayyar and Fisser (this volume), the blended support environment was deemed to be as effective as the human support environment for developing the competencies and attitudes required, but the blended environment additionally included the possibility of *communication* among team members, between different teams, and with the course instructor. Participants appreciated this flexibility of the online environment. Further, Agyei (this volume) found that *readily available* resources are more likely to influence teacher daily practice.

Structural Aspects of Infrastructure to Support CCD

For Curriculum Innovation

Bakah, Nihuka, and Arkato Gendole (this volume) stressed the need to incorporate CCD in the *policy* structure of the organizations. Their data showed that failure to do so creates vulnerability of the innovation at the departmental and institutional levels. They showed how policy, habits, and organizational messages can be shaped to support CCD. Similarly, Albashiry (this volume) found that curricular leadership for sustained and systematic work was helped by incorporating a *decrease in workload* for participants, *providing incentives*, and *flexibility* in scheduling training sessions and other activities. In his study, these policy-endorsed structures created a positive work environment, positive attitudes toward the undertaking, and alleviated temporal tensions (with commitments to other activities).

In addition, findings in these studies showed the need for carefully *shaping participation*. For example, Handelzalts, Nieveen, and Van den Akker (this volume) identified a need to *provide structures for less formal interaction within and among teams*. Their study found that CCD teams benefit from two kinds of activities to compensate for the typical lack of informal interaction: (1) presentation of team progress to give an overview of development, share insights, and discuss challenges; and (2) study days to obtain clarity about the focus of the reform, culminating in the creation or receiving of easily applicable products (such as a timeline for envisioning the work process, or a framework for describing the curricular resources they are designing). Additionally, their findings demonstrated why it is important to *promote a focus on learners*. That is, the norms, expectations and conditions may allow teams to think broadly at times, but clearly ensure that learners remain at the center of the reform. For cases in which the designed materials are used by non-designers, Pareja Roblin and McKenney (this volume) identified the need to (set up structures that) *involve local organizations* that can assist teachers and project leaders with implementation, *before diffusion* to other sites.

For several studies, *planning for evolution*, including the timelines to realize this, proved essential. First, the data from Albashiry (this volume) clarified why timelines need to be *long-term and realistic*. Namely, a relatively extended time spent on CCD work is necessary to yield, implement, and sustain innovation. This is benefited by piecemeal evolution, which helps teachers cope with the novelty and complexity over time. This is why Handelzalts, Nieveen, and Van den Akker (this volume) advocated that the timelines allow teams to think big, but start small (i.e., formulate schoolwide intentions, but work stepwise toward these ends), while taking the time to attend to the fact that one size does not fit all (use a common framework, but provide room for specific choices). As well as in these two studies, the need to *accommodate gradual, iterative work* was identified in a literature review of both scientific and professional sources (Westbroek, de Vries, Walraven, Handelzalts, & McKenney (this volume). In addition, Gervedink Nijhuis (this volume) stressed the need to plan for adjustments that are informed by essential iterations, which were helpful for: continuous (re-)analysis of cultural influences and stakeholder preferences, and evolutionary design, especially in the early stages, to attend to cultural influences on stakeholder perceptions and transfer experiences. This aligns well with the findings of Handelzalts, Nieveen, and Van den Akker (this volume), who found the need to structurally *promote early experimentation*. They noticed that teachers require help with envisioning their (potential) future practice, and observed that pilots for implementation of partial materials had a positive effect on teacher understanding of reform implications for their students.

Finally, studies on curriculum innovation through CCD identified benefits associated with regular *access to expertise* in various forms. Handelzalts, Nieveen, and Van den Akker (this volume) found that teams benefited from having opportunities to engage with explicit information on the reform ambitions, and that this can come from *external input* as well as by undertaking *site visits* to schools implementing the desired kinds of reform. The literature review by Westbroek, de Vries, Walraven, Handelzalts, and McKenney (this volume) confirmed the importance of (structuring regular access to) external support. Their scientific corpus suggested that this was theory-driven and structural, whereas their professional corpus showed that this was most often concern-driven and incidental. Access to expertise in a packaged form was also identified as beneficial. Specifically, Agyei (this volume) observed that teams benefited from an orientation program that provided conceptual and theoretical information and linked this to practical applications, each of which was based on the *research literature*. Further, his finding that scaffolds for the desired types of teaching and learning experiences (embodying research-based expertise) made the most significant contribution to developing desired competencies explains why he argued for their structural integration.

For Teacher Learning

As with CCD for curriculum innovation, studies showed that the plans and structures that accommodated the strophic processes of *experimentation-reflection* were important for teacher learning. First, making the time for *implementation of the redesigned curriculum materials* in the classroom was a crucial factor that contributed to professional growth (Bakah (this volume). Second, in their study on teacher development of curriculum design expertise through implementation activities, Huizinga, Nieveen, and Handelzalts (this volume) found that the CCD teams required planned, explicit *support for evaluation* activities.

To support teacher learning both within and across teams, the establishment of *organizational routines* was found to be crucial. Handelzalts, Nieveen, and Van den Akker (this volume) identified a need to *provide structures for collaboration in and among teams.* Further Huizinga, Nieveen and Handelzalts (this volume) observed that the *number of support meetings* is important. Their data also clearly indicated that support meetings must take place *throughout all phases* of the design process (to help teachers understand the importance of analysis and evaluation activities, as well as design sub-steps).

Finally, Arkato Gendole and Coenders (this volume) pointed to a well-known but often under-estimated structural aspect of infrastructure, the *reward system*. Their data showed how the provision of *external rewards* such as financial incentives and certificates can play an important role in setting the stage for teacher engagement with CCD learning opportunities. Accordingly, the rewards must be *aligned with career perspectives*, for example, by boosting opportunities for promotion or endorsing the development of valued skills.

Reflections

Synthesis

To support future CCD work, the previous section reviewed the processes and outcomes of CCD, and the human, material, and structural aspects of infrastructure that could support them. To understand synergies and explore potential tensions between the supports needed, the discussion was structured in light of the two main goals of CCD: curriculum innovation and teacher learning. Table 22.1 synthesizes the key insights described above. Bold text in the table indicates within-column similarities, such as human aspects of infrastructure that were found to be important for both curriculum innovation and teacher learning.

Discussion

The findings synthesized in Table 22.1 shed new light on details of supportive CCD infrastructure, and clarify which elements apply to CCD in general, and which ones are needed for CCD aiming primarily at curriculum innovation or at teacher learning. While Table 22.1 offers new elements and nuances, the key themes identified are largely consistent with findings from other studies on curriculum innovation and teacher learning. Here, attention is given to the themes within each aspect of infrastructure that were found to be similar for both goals.

Key themes related to the *human* aspects of infrastructure required in both cases were leadership, expert facilitation, and the presence of specific and varied expertise within the CCD team. The importance of leadership in CCD has been identified in other studies (Binkhorst, Poortman, & Van Joolingen, 2017), along with the fact that providing adequate leadership is challenging (Becuwe, Tondeur, Pareja Roblin, Thys, & Castelein, 2016). Further, commitment from leadership was shown to be essential, especially for ensuring that activities and resources are directed toward activity that would be productive for meeting CCD goals. The importance of unravelling how power and authority affect CCD was discussed by Penuel (this volume). Further, existing research is aligned with the finding that CCD requires expert facilitators (Boschman et al., 2016). The facilitator's task of combining both shared and vertical leadership styles has been described as challenging, even paradoxical (Binci, Cerruti, & Braganza, 2016). Binkhorst et al. (2018) described a stepwise approach to supporting the combination of both vertical and shared leadership, though they acknowledged that this work remains a challenging balancing act. Finally, these studies are aligned with previous research which shows that, within the team (and across all roles) CCD requires specific and varied expertise. This includes knowledge of models and frameworks to guide design; participant experiences as well as reflections on and responses to the environment; and knowledge of what designers actually do, as well as how and why they do it (McKenney, Kali,

Table 22.1 Findings on the processes and outcomes of CCD, and the infrastructure to support them

	CCD processes and outcomes	Infrastructure to support CCD		
		Human	Material	Structural
Curriculum innovation	Processes to expect	Anticipate roles	Provide documents	Policy
	Highly varied (even in similar reform settings)	Understand that (perceived) roles differ by project and by person	Research **literature** (theoretical and empirical)	Decrease workload
	Design is collaborative but construction is individual	Team characteristics mediate team functioning	**High quality guiding documents**	Provide incentives
	Interaction and interdependence	**Multidisciplinary expertise** in team is beneficial	**Exemplary materials**, lesson plans, and products embodying the abstract reform ideas and scaffolding desired practices	**Schedule meetings** (requires flexibility in the organization)
	Viewed as bottom-up	Ensure leadership		Shape participation
	Includes sensitization to needs of others (to understand and implement reform)	**Curricular leadership**		**Provide structures for less formal interaction within and among teams**
	Outcomes found	**Commitment from management crucial**		Promote focus on learners
	Clear vision supports productivity	**Leadership style attuned to team needs**		Involve local organizations before diffusion
	Structure supports productivity	Culture of support, responsibility and distributed leadership		Plan for evolution
	Alignment of ideals with perceived and (sometimes) attained curriculum	Develop shared understanding and expectations		Use long-term and realistic timelines
	May conflict	Involve stakeholders and facilitate them		Accommodate gradual, iterative work
	with existing	Develop shared awareness		Promote early **experimentation**

(continued)

Table 22.1 (continued)

	CCD processes and outcomes	Infrastructure to support CCD		
		Human	Material	Structural
	collaboration	Understand, expect, and appreciate individual and cultural differences		Provide access to expertise
	culture, schedules, or responsibilities	**Blend systematic and relational approaches**		Facilitate external input (experts, site visits)
				Promote use of data (from analysis or evaluation)
				Promote use of research literature
Teacher learning	Processes to expect	Prepare expert facilitators to support sharing	Provide documents	Endorse experimentation-reflection
	Exchange and validation of expertise	Of knowledge, skills, experiences, challenges	**Templates and tools**	**Implementation** of the (re-) designed materials was crucial for their learning
	Highly varied classroom implementation (even in similar settings)	**Expert facilitation** needed to support reflection (e.g., on classroom implementation)	**Exemplary lesson materials**	Planned, explicit **support for evaluation (and use of its data)**
	Design expertise present, but limited (analysis or) evaluation knowledge and skills	**Substantive expertise** needed/ shared in team	Collaboration guidelines	Develop organizational routines
	Outcomes found	**Design process expertise** needed by facilitators	Learning and informative **literature**	**Provide structures for collaboration within and among teams**
	Improved understanding and appreciation of reform	**Blend of proactive and reactive facilitator support**	Consider digital tools	**Ensure sufficient number of support meetings**

(continued)

Table 22.1 (continued)

	CCD processes and outcomes	Infrastructure to support CCD		
		Human	Material	Structural
	Increased knowledge and skills (e.g., CLT, e-learning, affordances and constraints of [technology-based] resources, engineering)	Ensure project coordination and management support	Communication tools	Ensure that meetings continue throughout all phases
	Ownership, commitment and appreciation	**Planning and monitoring skills** needed	Readily available resources are more likely to influence daily practice	Review reward system
		Support from management crucial		External rewards
				Aligned with career perspectives

Bold indicates within-column similarities between curriculum development and teacher development

Markauskaite, & Voogt, 2015), in addition to the knowledge, skills and attitudes teachers need to understand and meet the needs of their learners (McKenney, 2017).

The *material* aspects of infrastructure that are crucial for both curriculum innovation and teacher learning through CCD include exemplary materials, tools and literature. Well-crafted exemplary materials support teacher understanding of reform intentions, subject matter content, pedagogy, or classroom orchestration (Pareja Roblin, Schunn, Bernstein, & McKenney, 2018). Tools supporting the work of teachers as designers can take multiple forms, including real-time or asynchronous communication aids, implicit or explicit procedural guidance, and customized or generic templates (McKenney, 2008). Given that scholars have often lamented practitioners' lack of interest in or use of literature, it seems promising that CDD teams craved it. But challenges of physical and intellectual accessibility of the literature persist. Further, to be effective, authors will need to attend to the distinct priorities that guide teacher perceptions and use of educational research and evidence-based practices (Neal, Mills, McAlindon, Neal, & Lawlor, 2018).

Key supportive aspects of the CCD *infrastructure* were shown to include organizing time together, use of data, and iterative experimentation. The need to organize time for collaboration has been stressed in the literature repeatedly (e.g., in the review study by Van Veen et al., 2010). The issue has now become not whether time to work together is important, but rather, why does it seem so difficult for decision makers to understand? Data-informed decision making has long been good practice among designers, and has more recently been embraced by schools. Increasingly, resources have become available to guide educators toward making responsible use of data (e.g., Schildkamp, Lai, & Earl, 2012). In a similar vein, while early, agile, and iterative experimentation has been a cornerstone of design work for decades, CCD teams have often struggled for structural accommodation of such work (e.g., due to unrealistic project timelines or naïve understanding of CCD processes). This seems surprising given that experimentation has been widely recognized as essential to both curriculum innovation (Tytler, Symington, & Smith, 2011) and teacher learning (Clarke & Hollingsworth, 2002).

While the general findings shown in Table 22.1 do align with previous research on (CCD for) curriculum innovation and teacher learning, it is useful to notice similarities and distinctions between findings from projects with curriculum innovation as a primary rationale or goal, as opposed to those with teacher learning with a primary rationale or goal. First, as discussed above, there are similarities in several aspects of the desired infrastructure for productively supporting both curriculum innovation and teacher learning through CCD. As such, those aspects (in bold) could be considered essential for any CCD endeavor. Second, there are clear differences between the two. Understanding the differences in support needs seems crucial for providing an adequate infrastructure for the specific goals of a particular CCD project. Third, there do not appear to be any obvious tensions between the processes and outcomes related to each goal. This is not a surprise given the stance taken throughout this volume – that curriculum innovation and teacher professional development are mutually beneficial. Still, given that synergies and tensions often co-exist, it seems useful to have reviewed empirical evidence on this point. Similarly, no tensions seem evident between the human, material, or structural aspects of infrastructure CCD for each goal. Finally, it is worth noting that there were very limited data on the processes of infrastructuring. This shows that, at least for these cases, infrastructuring was rarely the explicit focus of empirical inquiry.

Even though specific tensions between support needs for curriculum innovation and for teacher learning do not appear to be present, it is clear that the overall support needs are extensive. As a result, it seems likely that most CCD projects would struggle to adequately meet the support needs for achieving either goal of curriculum innovation or teacher learning – a concern noted by most of the authors in this volume. Given that comprehensive support is not likely to be feasible in most settings, those who aspire to create and maintain a supportive infrastructure for CCD must anticipate the need to weigh trade-offs regarding where to target their efforts. The synthesis provided in Table 22.1 (along with the details above and throughout the chapters of this book) provides empirically-grounded starting points for making such decisions.

Recommendations for Further Research

The findings given in Table 22.1 constitute recommendations for policymakers and practitioners who would undertake CCD. Here, in light of those findings, recommendations for further research are given. First, in terms of CCD processes, it seems notable that only a few studies touched explicitly on the *supports needed by colleagues not participating* in the CCD team. Research on this topic seems especially relevant for achieving the goal of sustainability. Second, to assess the overall value of CCD for curriculum innovation, it seems prudent to investigate the *quality of the materials designed*. This was hardly undertaken in these studies, yet tools for doing so are available, such as the Educators Evaluating the Quality of Instructional Products (EQuIP) rubrics (https://www.achieve.org/our-initiatives/equip/about-equip). While some research into the human aspects of infrastructure provides insight into *how to prepare leadership and facilitators*, additional work in this area is needed, as many challenges remain. While materials to support curriculum innovation and teacher learning in general are present, further research is needed to design, test, and refine *resources specifically for CCD teams*. In so doing, they should take into account the differing needs of teams prioritizing curriculum innovation, in contrast to those prioritizing teacher learning. On the whole, the structural aspects of infrastructure to support CCD seem particularly challenging, because issues of time together and planning for iterative experimentation have been predictable based on the existing literature. Research is therefore needed to understand the *causes of these persistent problems* and to identify ways to infrastructure solutions together. Finally, we need studies that reveal how to *organize the processes of infrastructuring*, as these have rarely been the explicit focus of empirical inquiry.

Closing Remarks

The purpose of this chapter was to explore whether and how the infrastructure needed for CCD targeting curriculum innovation aligns with that required by CCD for teacher learning, and vice versa. This exploration was undertaken by distilling key insights from the cases described throughout this book, using the human, material, and structural aspects of infrastructure as a lens. The evidence synthesized from the chapters in this volume pointed toward nine key elements of the infrastructure to support both curriculum innovation and teacher learning through CCD. For both goals, crucial human aspects of infrastructure were *leadership, expert facilitation, and expertise in the team*; crucial material aspects of infrastructure were *exemplary materials, tools, and literature*; and crucial structural aspects of infrastructure were *organizing time together, promoting use of data, and facilitating iterative experimentation*. Simultaneously, this chapter also identified important elements of the human, material, and structural aspects of CCD infrastructure that are specific to each distinct primary goal, namely, curriculum innovation or teacher learning (shown as plain text in Table 22.1).

As described by the editors in the first chapter of this volume, this book was designed to provide international perspectives on the active involvement of teachers in CCD for sustainable curriculum innovation and teacher learning across diverse contexts. The chapters throughout this book illustrate various forms of synergies between curriculum development and teacher learning, as well as the social, cultural, and activity-based nature of CCD work. Penuel (this volume) argued for the importance of leveraging CCD not only to reach goals of curriculum change and teacher learning, but also to build collective capacity for equitable change. Toward that end, this chapter offers empirically-derived priorities for infrastructuring the contexts in which CCD is undertaken.

References

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10–20.

Ball, D., & Cohen, D. (1996). Reform by the book: What is – Or might be – The role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6–8, 14.

Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 2–22). San Francisco: Jossey Bass.

Becuwe, H., Tondeur, J., Pareja Roblin, N., Thys, J., & Castelein, E. (2016). Teacher design teams as a strategy for professional development: The role of the facilitator. *Educational Research and Evaluation, 22*(3–4), 141–154.

Ben-Peretz, M. (1990). *The teacher-curriculum encounter*. Albany, NY: State University of New York Press.

Binci, D., Cerruti, C., & Braganza, A. (2016). Do vertical and shared leadership need each other in change management? *The Leadership & Organization Development Journal, 37*(5), 558–578. https://doi.org/10.1108/LODJ-08-2014-0166

Binkhorst, F., Poortman, C. L., McKenney, S., & van Joolingen, W. R. (2018). Revealing the balancing act of vertical and shared leadership in teacher design teams. *Teaching and Teacher Education, 72*, 1–12.

Binkhorst, F., Poortman, C. L., & Van Joolingen, W. R. (2017). A qualitative analysis of teacher design teams: In-depth insights into their process and links with their outcomes. *Studies in Educational Evaluation, 55*, 135–144.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*, 3–15.

Boschman, F., McKenney, S., Pieters, J., & Voogt, J. (2016). Exploring the role of content knowledge in teacher design conversations. *Journal of Computer Assisted Learning, 32*(2), 157–169. https://doi.org/10.1111/jcal.12124

Boschman, F., McKenney, S., & Voogt, J. (2014). Understanding decision making in teachers' curriculum design approaches. *Educational Technology Research and Development, 62*, 393–416.

Boschman, F., McKenney, S., & Voogt, J. (2015). Exploring teachers' use of TPACK in design talk: The collaborative design of technology-rich early literacy activities. *Computers & Education, 82*, 250–262.

Brown, J. S., & Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization Science, 2*(1), 40–57.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*(8), 947–967.

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher, 23*(7), 13–20.

Coburn, C., & Russell, J. (2008a). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis, 30*(3), 203–235.

Coburn, C., & Russell, J. (2008b). Getting the most out of professional learning communities and coaching: Promoting interactions that support instructional improvement. *Learning Policy Brief, 1*(3), 1–5.

Coburn, C. E., Penuel, W. R., & Geil, K. E. (2013). *Research-practice partnerships: A strategy for leveraging research for educational improvement in school districts*. Retrieved from http://files.eric.ed.gov/fulltext/ED568396.pdf

Cochran-Smith, M., & Lytle, S. L. (2001). Beyond certainty: Taking an inquiry stance on practice. In A. Lieberman & L. Miller (Eds.), *Teachers caught in the action: Professional development that matters* (pp. 45–58). New York: Teachers College Press.

Cviko, A., McKenney, S., & Voogt, J. (2014). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers & Education, 72*, 68–79.

Dantec, C. A. L., & DiSalvo, C. (2013). Infrastructuring and the formation of publics in participatory design. *Social Studies of Science, 43*(2), 241–264.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan, 76*(8), 597–604.

Davis, E., & Krajcik, J. (2005). Designing educative curriculum materials to promote teacher learning. *Educational Researcher, 34*(3), 3–14.

Diamond, J. B., & Spillane, J. P. (2004). High-stakes accountability in urban elementary schools: Challenging or reproducing inequality? *Teachers College Record, 106*(6), 1145–1176.

Dolle, J. R., Gomez, L. M., Russell, J. L., & Bryk, A. S. (2013). More than a network: Building professional communities for educational improvement. *National Society for the Study of Education Yearbook, 112*, 443–463.

Drake, C., Land, T., & Tyminski, A. (2014). Using educative curriculum materials to support the development of prospective teachers' knowledge. *Educational Researcher, 43*(3), 154–162.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Gerard, L. F., Bowyer, J. B., & Linn, M. C. (2010). How does a community of principals develop leadership for technology-enhanced science. *Journal of School Leadership, 20*(2), 145–183.

Grossman, P., & Thompson, C. (2008). Learning from curriculum materials: Scaffolds for new teachers? *Teaching and Teacher Education, 24*, 2014–2026.

Hargreaves, A. (2003). *Teaching in the knowledge society: Education in the age of insecurity*. New York: Teachers College Press.

Hopkins, M., & Spillane, J. P. (2015). Conceptualizing relations between instructional guidance infrastructure (IGI) and teachers' beliefs about mathematics instruction: Regulative, normative, and cultural-cognitive considerations. *Journal of Educational Change, 16*(4), 421–450.

Hopkins, M., Spillane, J. P., Jakopovic, P., & Heaton, R. M. (2013). Infrastructure redesign and instructional reform in mathematics. *Elementary School Journal, 114*(2), 200–224.

Hord, S. M. (2009). Professional learning communities. *Journal of Staff Development, 30*(1), 40–43.

Horn, I. S., Garner, B., Kane, B. D., & Brasel, J. (2016). A taxonomy of instructional learning opportunities in teachers' workgroup conversations. *Journal of Teacher Education, 68*, 41–54. https://doi.org/10.1177/0022487116676315

Horn, I. S., & Kane, B. D. (2015). Opportunities for professional learning in mathematics teacher workgroup conversations: Relationships to instructional expertise. *Journal of the Learning Sciences, 24*(3), 373–418.

Kali, Y., McKenney, S., & Sagy, O. (2015). Teachers as designers of technology enhanced learning. *Instructional Science, 43*(2), 173–179.

Kali, Y., & Ronen-Fuhrmann, T. (2011). Teaching to design educational technologies. *The International Journal of Learning and Technology, 6*(1), 4–23.

Koehler, M., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research, 32*(2), 131–152.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lee, O., Penfield, R., & Maerten-Rivera, J. (2009). Effects of fidelity of implementation on science achievement gains among English language learners. *Journal of Research in Science Teaching, 46*(7), 836–859.

Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher, 35*(3), 3–14.

Linn, M. C., Gerard, L., Matuk, C., & McElhaney, K. W. (2016). Science education: From separation to integration. *Review of Research in Education, 40*(1), 529–587.

Little, J. W. (1999). Organizing schools for teacher learning. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 233–262). San Francisco: Jossey-Bass.

McKenney, S. (2008). Shaping computer-based support for curriculum developers. *Computers & Education, 50*(1), 248–261.

McKenney, S. (2013). Designing and researching technology enhanced learning for the zone of proximal implementation. *Research in Learning Technology, 21*, 17374.

McKenney, S. (2017). *Een infrastructuur voor de professionele groei van docenten [Infrastructuring teacher professional growth; inaugural lecture]*. Enschede, The Netherlands: University of Twente.

McKenney, S., Kali, Y., Markauskaite, L., & Voogt, J. (2015). Teacher design knowledge for technology enhanced learning: An ecological framework for investigating assets and needs. *Instructional Science, 43*(2), 181–202.

Neal, J. W., Mills, K. J., McAlindon, K., Neal, Z. P., & Lawlor, J. A. (2018). Multiple audiences for encouraging research use: Uncovering a typology of educators. *Educational Administration Quarterly*. https://doi.org/10.1177/0013161x18785867

Pareja Roblin, N., Schunn, C., Bernstein, D., & McKenney, S. (2018). Exploring shifts in the characteristics of US government-funded science curriculum materials and their (unintended) consequences. *Studies in Science Education, 54*(1), 1–39.

Pareja Roblin, N., Schunn, C., & McKenney, S. (2018). What are critical features of science curriculum materials that impact student and teacher outcomes? *Science Education, 102*(2), 260–282.

Penuel, W. R. (2015). *Infrastructuring as a practice for promoting transformation and equity in design-based implementation research*. Paper presented at the meeting of the International Society for Design and Development in Education, Boulder, Colorado.

Penuel, W.R. (2019). Infrastructuring as a practice of design-based research for supporting and studying equitable implementation and sustainability of innovations. *Journal of the Learning Sciences*. https://doi.org/10.1080/10508406.2018.1552151

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal, 44*(4), 921–958.

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15.

Remillard, J. (2000). Can curriclum materials support teachers' learning? Two fourth-grade teachers' use of a new mathematics text. *The Elementary School Journal, 100*(4), 331–350.

Remillard, J. T., Herbel-Eisenmann, B. A., & Lloyd, G. M. (Eds.). (2011). *Mathematics teachers at work: Connecting curriculum materials and classroom instruction*. New York: Routledge.

Resnick, L., Levine, J., & Teasley, S. (Eds.). (1991). *Perspectives on socially shared cognition*. Washington, DC: American Psychological Association.

Schildkamp, K., Lai, M. K., & Earl, L. (Eds.). (2012). *Data-based decision making in education: Challenges and opportunities* (Vol. 17). Dordrecht, The Netherlands: Springer.

Star, S. L., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research, 7*(1), 111–134.

Stenhouse, L. (Ed.). (1980). *Curriculum research and development in action*. London: Heinemann.

Tytler, R., Symington, D., & Smith, C. (2011). A curriculum innovation framework for science, technology and mathematics education. *Research in Science Education, 41*(1), 19–38.

Van den Akker, J. (1998). The science curriculum: Between ideals and outcomes. In B. Fraser & K. Tobin (Eds.), *International handbook of science education* (pp. 421–447). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Van Veen, K., Zwart, R., Meirink, J., & Verloop, N. (2010). *Professionele ontwikkeling van leraren: Een reviewstudie naar effectieve kenmerken van professionaliseringsinterventies van leraren. [Professional development of teachers: A review study on effective characteristics of professionalization interventions]*. Leiden, The Netherlands: ICLON/Expertisecentrum Leren van Docenten.

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education, 96*(5), 878–903.