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

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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

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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.

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