Chapter 3
Design Talk in Teacher Teams: What Happens During the Collaborative Design of ICT-Rich Material for Early Literacy Learning?

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Origins of the Study

For teachers, integrating ICT (Information and Communication Technology) in their teaching and in their teaching materials is conceptually challenging and practically demanding (Labbo et al., 2003; Olson, 2000). While teachers are able to use ICT for every-day personal use (e-mail, word-processing), they often lack competencies to integrate ICT with subject matter and pedagogy in a specific context (Koehler & Mishra, 2008). Scholarship on the subject of ICT integration increasingly promotes teachers' active participation in the design of learning material. Involving teachers as designers has been advocated as a feasible and desirable way of reaching sustained implementation of an innovation in practice (Bakah, Voogt, & Pieters, 2012; Carlgren, 1999; Clandinin & Connelly, 1992; Handelzalts, 2009). Active engagement does not only increase ownership but offer opportunities for learning, and it results in material that is more in line with classroom practice since teachers know their children and the context better than anyone outside of their classrooms (Ben-Peretz, 1990; Borko, 2004; Voogt et al., 2015). A growing number

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of studies in which teams of teachers act as designers of ICT integrated curriculum material shows that those teachers actually yield progression in implementing ICT in their classrooms (see for instance Cviko, McKenney, & Voogt, 2013).

The study presented in this chapter is set in the context of kindergarten education, with a specific focus on developing functional literacy. Functional literacy is the understanding that written language has a communicative purpose. Understanding the functions of print develops in many ways, especially when children engage in authentic ways with written products. ICT can enable even non-reading kindergarteners to "write" a variety of products and thereby experience these functions, first hand. In this study, teachers designed learning materials for use with PictoPal. PictoPal is a learning environment consisting of on- and off-computer activities that involve making a written product and using this product in an application activity. An example of a PictoPal on-computer activity is that children compose and print a list of ingredients for making dinner. They do this using a word processor called Clicker®, that features pre-written, spoken, and illustrated words with which children compose their texts. Off-computer, children then engage in an application activity such as "buying" the ingredients on their list (e.g., in the store corner of the classroom) in order to "cook" a dinner (e.g., in the kitchen area of the classroom). PictoPal has shown promising results in children's attainment of functional literacy (Cviko, McKenney, & Voogt, 2012; McKenney & Voogt, 2009).

Teachers' joint participation in designing learning material is a form of collaborative curriculum design. Here, the term *curriculum* is used to refer to a plan for learning (Taba, 1962). This chapter focuses on the technical-professional perspective of curriculum (the making of a plan for learning) as undertaken on the micro-level (learning events and learning materials) (van den Akker, 2003). Consequently, the term, *learning material*, refers to all resources that are used in this plan. In this study, learning material refers to the on-computer learner material as well as the off-computer application activity plans, both of which are designed by teachers. During a 3-year period (2010–2013), a total of 21 kindergarten teachers were involved, divided over six teacher design teams (TDTs). These teams of kindergarten teachers gained experience in designing PictoPal learning materials. All of these teachers participated voluntarily after an open call was issued. Each TDT consisted of at least two teachers.

Little is understood about how teachers make decisions while designing learning material and what they base their decisions on when they collaborate in TDTs. Most studies on TDTs focus on outcomes of the design process in terms of changes in classroom practice, implementation of material, student learning or teachers' knowledge development (Cviko et al., 2013; George & Lubben, 2002; Parke & Coble, 1997). Voogt et al. (2011) conducted a review on literature on TDTs and concluded that there is a lack of studies that take a micro-perspective. Such a micro-perspective means taking a closer look at what design actually is, how it is being conducted by teachers and how it occurs in and through conversation. This study is set out to take such a micro-perspective and investigates in depth, the collaborative design conversations that occur as TDTs design PictoPal

material. In accordance with existing work in this area, the collaborative design conversations in this study are referred to as "design talk" (cf. Koehler, Mishra, & Yahya, 2007). The study is guided by the following research question: *What is the nature and content of teachers' design talk during collaborative design of ICT rich learning for early literacy?*

Theoretical Framework

Nature of Design Talk: What Does It Look Like?

The nature of design talk pertains to the kind of conversation that occurs. The content of design talk reflects key issues raised during these conversations. In this section, the concepts under study regarding the nature of design talk are discussed; thereafter, concepts pertaining to the contents are discussed.

Deliberation During Collaborative Design

Walker (1971) provided groundbreaking work in his analysis of deliberation during curriculum design. His Structural Analysis of Curriculum Deliberation (SACD) framework contains a description of the kinds of interactions that may occur during collaborative design. He identified the following types of episodic interactions in his classic study of design team interaction: brainstorms, issues, reports and explication. Underpinning those interactions, typically in the form of utterances by individuals, are ideas, and orientations brought in by design team participants. According to Walker, the kinds of points made within design team interactions are: pointing out problems; proposing solutions; presenting arguments; or offering instances from first or second hand experience. Walker (1971) categories of episodes and single utterances provide a starting point to study the nature of design talk.

Depth of Conversations

Collaborative design has the potential to serve as a context for teacher learning (Handelzalts, 2009; Voogt et al., 2011). Addressing design challenges may be considered a form of problem solving. In the case of problems for which teachers do not have ready-made solutions, teachers must use all of their available knowledge. Working in a team to solve a design problem may even be more beneficial to teacher learning. When teachers do not have to work alone but in a team, they may come up with solutions they would not have thought of as individuals. Also, as design problems are complex, solving them together with other teachers might help teachers

overcome struggles in solving design problems that they would not have been able to solve individually. Conversations that emerge during problem solving have the potential for teacher learning (Putnam & Borko, 2000). This is particularly the case when teachers participate in sharing information, analyzing a problem, synthesizing information to find a solution, or use their collective thought to envision a solution and reflect on actions taken (Henry, 2012).

To understand the nature of design tasks as a potential context for learning, this study investigates the depth of the inquiry in design talk. Based on Henry (2012), the following depths of inquiry are distinguished and studied in our study: no collaborative inquiry; shallow inquiry by sharing knowledge and information; deep inquiry, building understanding by analyzing and synthesizing information; and deep inquiry by using understanding to achieve learning by planning. The kinds of collaboration that form a context for learning are found in conversations in which teachers not only share information (shallow inquiry) but also construct new knowledge by combining perspectives, applying what they know about the problem, and coming up with novel, effective, and enjoyable solutions (deep inquiry).

Subject-Matter Expertise

Studies recommend that TDTs benefit from support (Handelzalts, 2009; Huizinga, Handelzalts, Nieveen, & Voogt, 2014). Substantive support to TDTs focuses on subject-matter and how to plan for teaching that subject matter. Substantive support can be provided by an external expert, and by making suggestions and providing information during the design process. Deketelaere and Kelchtermans (1996) found that the goal of such support lies in stating opinions, sharing own knowledge and beliefs, contrasting, fueling discussions, and relinquishing misconceptions.

Substantive support provided by an external expert can influence the nature of design talk. In this study, subject-matter support was provided by an experienced teacher-trainer. The kind of support provided can be seen as "just-in-time": the subject-matter expert aligned her support to the needs the design team displayed through their conversation. At times, design team needs were explicit, such as requests to provide specific information. At other times, the needs were implicit, like when the outside expert felt that information would be helpful to bring the design process one step further. The nature of outside subject matter expertise brought into design conversations can be operationalized as: ask for clarification, make confirming remarks, state critique, provide suggestions, or offer explanations.

Content of Design Talk: What Do Teachers Consider?

In this study, the content of design talk reflects the various considerations underlying collaborative curriculum decision-making. First, teachers bring their own existing orientations to the design table. The term, existing orientations,

refers to teachers' own technological pedagogical content knowledge (TPACK) as well as their design knowledge. Second, teachers' practical concerns shape their discussions and decision-making. Third, because teachers' classrooms are part of an educational ecosystem, external priorities (originating from outside the classroom) wield influence on design decision-making. The following sections explain the term TPACK and what is meant by design knowledge. Thereafter, practical concerns and external priorities are briefly explained.

Existing Orientations

In the context of technology-related design, core knowledge that teachers' need is termed technological pedagogical content knowledge (later abbreviated as TPACK) (Koehler & Mishra, 2005). TPACK can be seen as the whole of knowledge and insights that underlie teachers' actions with ICT in practice (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). The TPACK framework acknowledges that, for effective use of ICT, teachers need integrated knowledge of content and pedagogy and ICT. Several studies employ TPACK as a conceptual framework to understand how teachers explicate their understanding of how knowledge of technology, pedagogy and content interact, for instance during instructional decision-making (Doering, Veletsianos, Scharber, & Miller, 2009; Graham, 2011; Graham, Borup, & Smith, 2012; Manfra & Hammond, 2008).

In this study, teachers' TPACK is investigated with regard to early literacy development in kindergarten. Teaching early literacy entails fostering children's understanding and skills related to reading (readiness), writing (readiness), listening and speaking. Based on international literature (cf. Dickinson & Neuman, 2007; McKenney & Bradley, in press; Verhoeven & Aarnoutse, 1999) three strands of early literacy concepts and skills may be distinguished. The (de)coding strand includes elements such as: linguistic consciousness, phonemic awareness and alphabetic principle. The text comprehension strand includes: book orientation, story understanding and listening comprehension. The functional literacy strand includes: understanding the relationship between spoken and written words and understanding the communicative functions of different genres of text.

This study looks at how knowledge about early literacy, teaching and learning in kindergarten and knowledge about ICT is integrated in curriculum design and expressed in design talk. In this study, the TPACK framework is operationalized as follows:

- Pedagogical knowledge (PK): knowledge about kindergarten teaching and learning as well as socio-emotional development of kindergartners;
- Content knowledge (CK): knowledge about early literacy concepts such as phonological awareness, book-reading, vocabulary development;
- Pedagogical content knowledge (PCK): knowledge about how to apply general instructional strategies in kindergarten to teach and develop early literacy;
- Technological knowledge (TK): general knowledge about technology such as operating computers, web 2.0, email;

- Technological content knowledge (TCK): knowledge about PictoPal that afford the transformation of specific early literacy subject matter;
- Technological pedagogical knowledge (TPK): knowledge about how to use PictoPal in an appropriate kindergarten related fashion such as used to stimulate cooperative learning;
- Technological pedagogical content knowledge (TPCK): how to use the affordances of PictoPal to teach specific early literacy content within a kindergarten appropriate fashion.

As teacher knowledge is intertwined with teacher beliefs (Pajares, 1992), our operationalization of TPACK also includes teacher beliefs. For instance, beliefs about teaching and learning are found to influence, and for a great deal steer, teacher decision making regarding technology use (Ertmer & Ottenbreit-Leftwich, 2010; Prestridge, 2012; Tondeur, Hermans, van Braak, & Valcke, 2008). Tondeur et al. (2008) found that teachers who held constructivist beliefs on teaching and learning, were more inclined to use ICT than teachers who held more traditional beliefs. Similarly, Kim, Kim, Lee, Spector, and DeMeester (2013) conclude that teachers' fundamental beliefs about effective ways of teaching underlie their technology integration practices. In the context of this study (kindergarten), strong pedagogical beliefs have been shown to drive teachers' actions, practices, and decision-making (Buchanan, Burts, Bidner, White, & Charlesworth, 1998; Stipek & Byler, 1997).

Teachers are designers, as Clandinin and Connelly (1992) and Laurillard (2012) have asserted. Teachers design in their everyday lesson preparation and enactment. Whether it is creating tangible material from scratch or adapting existing material to accommodate the instructional needs of their classroom, design is an integral part of the teaching profession. In addition to TPACK, teachers use their design knowledge to adjust plans and resources to meet learning goals and/or make them more useful in their own practice.

Design knowledge entails both the tacit and explicit knowledge that teachers use during design. Following Lundwall and Johnson (1994), McKenney, Kali, Markauskaite, and Voogt (2015) look specifically at the design of technology-enhanced learning. They describe different kinds of knowledge and beliefs that underpin teacher abilities to "engage skilfully in design" (McKenney et al., 2015, p. 3). *Know-what* refers to conceptual knowledge and facts such as subject-matter content, pedagogical theories, and TPACK. *Know-why* pertains to teacher's knowledge and beliefs about principles of learning and teaching. *Know-how* is a teacher's skill to produce what is needed, such as learning materials, instructional events or classroom management.

Practical Concerns

In addition to existing knowledge and beliefs, practical concerns influence teacher decision-making during design. Practical concerns are what teachers perceive as important factors in classroom practice that influence how designs will (not) function. A classroom is a complex ecology and for designs to function well, this

complexity must be taken into consideration. Many teachers intuitively foresee practical concerns during design. As such, they can be quite influential in teachers' decision making (Doyle & Ponder, 1977). In fact, some studies have shown that practical concerns dominate teacher discussions during collaborative curriculum design (Handelzalts, 2009; Kerr, 1981). Types of practical concerns raised during collaborative design include: (a) organizational issues ("how much time is available, how are students seated, what classroom do I have available") (de Kock, Sleegers, & Voeten, 2005); (b) relationship between student and activity (how will students react to this, what will students do with it) (Deketelaere & Kelchtermans, 1996; George & Lubben, 2002; Parke & Coble, 1997); and (c) how subject-matter is presented to students in such a way that it becomes feasible in practice (Handelzalts, 2009).

External Priorities

While teachers have a large degree of freedom in deciding what occurs in their classrooms, certain priorities of stakeholders other than the teachers themselves influence both design and implementation. External priorities may be set by stakeholders on different levels varying from macro-level (e.g., national standards), publishers (e.g., textbooks) to the (near) school level, as expressed by school boards (e.g., local policy), principals or colleagues within communities of practice. For instance, subject matter content priorities are often set in curriculum material such as textbooks and software, which are designed by others then teachers themselves. Also, school boards or principals may set a variety of priorities, for instance about the vision on education, teaching or the role of the learner. When designing, teachers often take such external priorities into consideration. In kindergarten, external priorities might for instance be: developmentally appropriate practices in teaching and learning (NAEYC, 2009), appropriate practices in computer use by young children (NAEYC, 1996), early-literacy content knowledge, and policies (Buchanan et al., 1998; Stipek & Byler, 1997; Turbill, 2001). External priorities are often implicitly embedded in the organizational context in which teachers work.

Methods

Research Questions

The present study focused on the design talk of six teams of kindergarten teachers engaged in the design of PictoPal learning material. Research was conducted to investigate the nature of design talk in terms of: deliberative interactions; depth of conversations; and how substantive expertise is provided and utilized. Simultaneously, the study examined how existing orientations, practical concerns and external

priorities featured in the content of design talk. The main research question was: *What is the nature and content of teacher design talk during the collaborative design of ICT rich learning for early literacy?* To answer the main question, four studies were conducted.

Research Approach

A qualitative case study methodology (Yin, 2003) was applied to understand design talk as it occurred in a real-life context. Qualitative data were gathered through semi-structured interviews and transcripts of three consecutive design conversations. In the first study, three cases of teacher teams' explicated design reasoning were investigated. In each case, existing orientations of the team (before the design) and the explicated design reasoning of the team (during design) were examined. The second study featured one team of teachers. This case study focused on understanding if and how collaborative design conversations could serve as a rich context for teacher learning. In the third study, a subject-matter expert supported two TDTs. Design talk analysis of these two cases focused on how participant content knowledge was intertwined with other domains of knowledge, and how this was reflected in their design talk. Finally, the fourth study took individual teachers as the unit of analysis. Four cases were investigated in this study. The focus was on exploring how the explicated design knowledge of individual teachers contributes to the overall team design.

Interview Data Analysis

In sub-studies 1 and 4, teachers' existing orientations were investigated using semi-structured interviews. The analysis of the semi-structured interviews occurred on written transcripts. In the first study, teachers' existing orientations were studied with teams as unit of analysis. Individual teachers responses that pertained to either pedagogy or ICT or early literacy or curriculum design were descriptively coded as such (pedagogy, ICT, early literacy, or curriculum design). Codes were refined through constant comparison (Glaser & Strauss, 1999). Then, categories of inductive codes were made through axial coding which resulted in sub-codes within pedagogy, ICT, early literacy, or curriculum design. These category codes were also refined through constant comparison.

The fourth study focused on individual teacher design knowledge. The same semi-structured interview scheme as in the first study was used. In the fourth study, coding however occurred on the categories of design knowledge. Specifically, coding was undertaken to identify: know-why, know-what, and know-how. Through constant comparison (Glaser & Strauss, 1999), these codes were refined.

Conversation Analysis

The written transcripts of the design talk were analyzed using conversation analysis techniques derived from the work of Sacks, Schegloff, and Jefferson (1974). Throughout the decades in which conversation has matured as an analytical approach (see Schegloff, 2007), conversation analysis has also focused on the contents reflected in conversation. Conversation analysis techniques are being increasingly applied to study teacher learning in collaboration (Adger, Hoyle, & Dickinson, 2004; Ben-Peretz & Kupferberg, 2007; Crespo, 2006; Horn, 2010; Little, 2002). Design talk may seem unstructured; many teachers talk and the conversation is often fast-paced, making it difficult to interpret what teachers say. Still, it is organized following rules of ordinary conversation, derived from Sacks et al. (1974):

- Conversation is interaction, meaning that speakers turn their attention to another speaker.
- Speakers take turns and conversation, while the flow of the conversation may seem unstructured, conversation itself is orderly.
- Finishing each-others' turn and repeating what another speaker said, signals agreement.
- Understanding emerges as speakers talk about the same topics.

The conversations in the teams, capturing design talk, were analyzed systematically. The nature and the content of design talk were studied on three levels: episodes, topical exchanges, and individual utterances. In the first study, the interactions were studied in terms of the kinds of deliberative episodes that occur, and the kinds of individual utterances that emerge when teachers collaboratively design technology-rich learning material for early literacy. In the second study, the focus was on understanding the topical exchanges and how single utterances indicate depth of inquiry (none, shallow, analyze and plan). In the third study, the topical exchanges and single utterances were analyzed in terms of subject-matter expertise utilized and the nature of external support given (clarify, confirm, critique, explain, suggest) under naturalistic circumstances. In the fourth study, the single utterances of individuals were analyzed to portray how individual teachers explicate their design knowledge when working in TDTs.

Overview of the Sub-Studies

Study 1

The goal of the first study was to reach a better understanding of the intuitive decisions teachers make when designing a technology-rich learning environment for early literacy. This sub-study answered research questions about existing orientations, design team interactions, and argumentation in design teams. In this first study, three teams of teachers (one with substantial language expertise, one team of four regular teachers and one team of two regular kindergarten

teachers) were given an explanation of PictoPal's rationale before designing on- and off-computer materials and activities. Existing orientations (TPACK) were studied through interviews. Analysis of design talk was performed by looking at how existing orientations, practical concerns or external priorities were explicated during the design talk of these three groups of teachers. Furthermore, this study applied Walkers' SACD (see Section "Deliberation during collaborative design") to understand the decision making process itself.

Study 2

The second study focused on how collaborative design constitutes a context for teacher learning and how TPACK develops across time in design conversations. The research questions that this study answered were oriented to understanding how existing orientations (TPACK) were linked to practical concerns, external priorities and depth of inquiry. One team of teachers was involved. This study analyzed design talk on depth of inquiry (see Section "Depth of conversations"), TPACK and how practical concerns, existing orientations and external priorities influenced decision-making while creating PictoPal learning material.

Study 3

The third study investigated the role of content knowledge in conversations of kindergarten teachers during collaborative curriculum design of learning material for technology-enhanced learning. The research question of this study pertained to the manifestation of content knowledge in teacher conversations while designing ICT-rich materials for early literacy. In this study, two teams (one team of four and one team of two teachers) each engaged in the design of PictoPal learning material. Each team was supported by an early literacy expert (who was also teacher) with ample experience supporting kindergarten teachers. This study analyzed teachers' existing orientations toward early literacy in their design talk and how early literacy subject matter was integrated with knowledge about teaching (PCK), knowledge about content representations with ICT (TCK) and knowledge about how to teach early literacy with ICT (TPCK). Further, the nature of the contributions by the outside early literacy expert were analyzed.

Study 4

In the fourth study, individual teacher design knowledge was investigated during the collaborative design of PictoPal learning material. The study focused on how individual differences in design knowledge influenced the design process and the resulting products. The analysis identified individual teacher contributions relating know-what, know-why, and know-how, to understand the kinds of differences individual teachers bring to collaborative design processes.

Key Findings

Understanding Intuitive Decision Making in Collaborative Curriculum Design

The first study aimed to understand the decision-making that takes place in design teams, when the process is not prestructured. Three teams of teachers were involved in the study: one team of three language expert teachers, and two teams of kindergarten teachers. Semi-structured interviews were held to explore the teams' existing orientations technological pedagogical content knowledge (TPACK) and their curriculum design expertise prior to design. The analysis on decision-making in the teacher design teams focused on: teachers' existing orientations (knowledge and beliefs about technology, pedagogy, content, and curriculum design), practical concerns (concerns related to how to organize the activity and what kind of problems could occur in practice), and external priorities (priorities from outside stakeholders).

The findings of the interviews show that pedagogical beliefs, about teaching and learning in kindergarten, are a dominant lens through which technology is viewed. Furthermore, teachers state that they direct their attention to socio-emotional development of children first, before considering the kind of learning that has to take place. The interviews show that teachers use their own personal experiences most to feed the design of curriculum materials.

The analysis of the design talk suggests that design is mostly a form of brainstorm, occasionally interrupted by short moments in which issues and problems are discussed. These problems are mainly related to practical concerns, and teachers quickly find solutions. Existing orientations and external priorities were scarcely reflected in this data set. Overall, most of what teachers discussed was about practical concerns. However, when comparing the regular kindergarten teacher design talk with that of teachers with extensive early literacy expertise, the latter group explicated more of their knowledge and beliefs throughout the entire conversation. It was concluded in this study that teachers' natural inclination to design is solution-driven and that they frequently make conjectures regarding the functioning of the design in practice. Furthermore, teachers tend to focus their efforts on ensuring that the activities children will do are feasible in practice.

How Do Teachers Use and Develop TPACK During Collaborative Design

The second study focused on how teachers develop TPACK and ways in which design talk provides opportunities for teacher learning. One team of kindergarten teachers was involved in the study. Topical exchanges, units of design talk

that focused on one main topic, were analyzed. Analysis focused on: which domains of TPACK were explicated; and how these domains were linked to reasons given during decision-making (existing orientations, practical concerns or external priorities). Furthermore, this study also explored the depth of the conversations in the teams.

Findings revealed that the kinds of knowledge teachers introduced most to the conversations were PCK (pedagogical content knowledge) and TPCK (technological pedagogical content knowledge). General pedagogy did not emerge in isolation, but intertwined with the two other knowledge domains, i.e., as technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), or technological pedagogical content knowledge (TPCK). PCK and TPCK were closely linked to teachers' practical concerns.

The depth of conversations over time was also examined. The findings of this study showed that, across the three workshop sessions, teachers did reach deeper levels of inquiry (as evidenced by analyzing and planning). However, most of the design talk reflected lower levels of inquiry (sharing information). A pattern emerged in which teachers first share information by proposing what the learning activity could look like. This continues, uncontested, until another teacher casts doubt or makes an evaluative comment about the learning activity. Considerations for decision-making are mainly given by sharing information (what will the learning activity look like). When deeper levels of inquiry are reached, important decisions are made. Along the way, teachers establish a rationale, which then guides further practical design (what kind of learning activity and material, how to organize specific activities). Still, practical concerns dominate discussions of teachers and such discussions on practical concerns are shallow in depth.

This study suggests that deep inquiry emerges less frequently than shallow inquiry. Mostly, design talk reflects shallow inquiry. However, the moments in which teachers' design talk reflects deep inquiry do offer opportunities for learning. It appears that teachers develop their TPACK in such moments.

The Role of Content Knowledge in Collaborative Design

The aim of the third study was to explore the role of content knowledge (CK) of early literacy in teacher design talk. Two teams of teachers designed PictoPal learning material. These two teams were supported by an early literacy expert who elicited and provided subject matter information either upon teachers' request or when deemed useful by the early literacy expert herself. Analysis focused on how CK, TCK, PCK, and TPCK were reflected in the design talk of these teachers.

The findings of this study revealed that CK was utilized when teachers discussed the current goals and objectives of early literacy, set within specific themes in their classrooms. PCK was explicated when relating to current and

future classroom learning practices, or activities that would occur with written material. TCK was used when teachers discussed the on-screen layout of written materials that children would conduct. TPCK emerged as teachers discussed how children would produce the written material and how they would use the material in play-related application activities. Findings to the reasoning behind decisions showed that existing orientations (knowledge and beliefs) related mostly to CK and PCK, whereas practical concerns related mostly to TCK and TPCK. The contributions given most by the early literacy were mostly either recommendations or explanations. Recommendations were made pertaining to concrete learning activities, and explanations were provided in relation to CK, explaining concepts pertaining to early literacy. Finally, in this study two different kinds of practical concerns were observed: implementation related (pertaining to how to organize the activity, how much time) and design-related practical concerns (what the material should look like). Content knowledge seems to have served as an internal compass for designing the material and talking about these two kinds of practical concerns.

Individual Teachers' Design Knowledge During Collaborative Design

The fourth study aimed at understanding how individual teachers' design knowledge was utilized during design talk. One team of teachers was investigated (the same team of four teachers as was reported on in the third study). The data of the third study were reanalyzed using a different coding scheme, related to design knowledge (know-what, know-why, and know-how).

Findings of this study suggest that mostly, know-how was expressed during design talk. However, as the interviews also revealed, know-why played an important role because it showed to be underlying the know-how. Know-what was hardly expressed by teachers. This study also found differences between teachers. Of the four teachers, two teachers were inclined mostly to express know-how. These two teachers also made more contributions to the design than the other two teachers did. Of the other teachers, one teacher proportionally expressed more know-what and one teacher more know-why. This study highlights the variety in kinds of contributions made by individuals in teacher design teams.

Conclusions

This study aimed at understanding the nature and content of design talk in the context of collaborative design of ICT-rich learning material for early literacy. Based on the findings of this study, several conclusions can be drawn.

Nature of Design Talk

Brainstorms, Directed at Quickly Generating Solutions, Dominate Design Talk

The nature of design talk by teachers largely resembles a brainstorm. The first study showed that these brainstorms were lengthier and more frequent than moments in which problems were discussed. Teachers initiate the design process by brainstorming on a possible learning activity. By sharing ideas, teachers fill in details of these learning activities. Brainstorming is, as the second study showed, a kind of conversation in which teachers share information and opinions about learning activities to be designed, but do not engage in argumentation or reasoning. It can therefore be concluded that the nature of design talk in teachers' collaborative design is that of a brainstorm with a shallow level of inquiry and a strong focus on what learning activity should occur in practice and what the material should look like.

Conversations on Complex Problems Provide an Opportunity for Learning

While the dominant mode of conversation resembles brainstorm, design talk also includes moments in which teachers reach deeper conversations by discussing problems. These problems are predominantly practical in nature and vary in complexity. Problems that are less complex do not provide opportunities for learning. Teachers gravitate toward quickly finding solutions that are easy to implement. The problems that are more complex provide opportunities for learning. Teachers have to find solutions that work in practice and use their expertise as they reason through justification for the solutions. When justification of the solution is expressed, teachers also discuss the rationale for the decision they make. Eventually, after teachers agree with the solution, they revert back to brainstorming. Though less frequent, bursts of complex problem solving with deep inquiry are present in teacher design conversations.

Substantive Support Provided by an Outside Expert Matters Most in Recommendations or Explanations

Study three investigated the role of substantive considerations during design, especially through the input of an early literacy expert participating in two TDTs. The findings showed that the expert input frequently, though not always, influenced decision-making. The expert contributions that directly influenced decision-making were recommendations or explanations. Recommendations included advice for addressing specific kinds of problems, or suggestions during brainstorms. Explanations were given at varying moments and provided the other teachers with information on complex or less familiar (language-related)

concepts. The expert contributions treated as optional, and only those deemed by the group to be useful and/or feasible were ultimately incorporated into the design.

Content of Design Talk

TPCK and TCK Are Mostly Expressed in Relation to Practical Concerns and Dominate the Content of Design Talk

In the first study, practical concerns dominated design talk. In the second and third studies, these practical concerns were linked to TPCK and TCK. Linked to TPCK, these practical concerns related the design of the learning activities; linked to TCK, these practical concerns were related to the elements and layout of those elements on-screen. Teachers focused their design talk largely on fine-tuning these details. Often in design talk, they "picture" what the material and the activities will look like during use. This picture is refined until teachers are satisfied with the completeness and suitability, and judge it to be ready for implementation.

Teachers Rely Heavily on Their Existing Beliefs About Teaching and Learning to Shape Design

The findings of the first study led to the conclusion that teacher beliefs about teaching and learning in kindergarten influence how they teach early literacy and how they use technology. In other words, both content knowledge and technological knowledge were seen through a pedagogical frame of reference. For example, the first study showed that teacher beliefs about how motivate young children influenced their design of the PictoPal learning material. Specifically, reasons used during decision-making pertained to how they believed the learning activities would engage children when writing their own texts.

Teachers Rarely Explicate Content Knowledge in Isolation

Content knowledge alone was hardly expressed; most often it was integrated with pedagogy. In the first study, the interviews revealed the importance of creating activities in which children were engaged in authentic writing activities. Analysis of the design talk from the first, second and third studies also showed that teachers did indeed design learning activities to be engaging and authentic. Furthermore, the first study showed that teachers' content knowledge did not appear to be as comprehensive as their knowledge about pedagogy. Teachers mentioned concepts relating to early literacy, yet offered little elaboration of what these concepts meant to them; this was markedly different from the level of

detail given when describing their pedagogical perspectives. In the second study, teachers struggled when discussing topics related specifically to content knowledge. The third study showed that (the nonexpert) teachers struggled with subject-matter concepts, yet were able to express the associated learning goals. Yet even these moments were dominated by discussion of how these learning goals could best be attained, thus showing that decisions were more based on teachers' PCK than on their CK.

Teacher Design Knowledge Is Mostly Expressed as Know-How, Yet Underpinned by Know-Why

The fourth study focused on teachers' individual design knowledge. Know-how was mostly expressed and it related to what the learning activities would look like. Know-what was hardly expressed. The study concluded that what individual teachers know to be true and believe to be important (know-why) steers the contributions that they make to the design (know-how).

External Priorities Feature Minimally in Teacher Design Talk

Teachers' perceptions of external priorities are occasionally expressed. However, when these reasons conflict with arguments from teachers own existing orientations, their knowledge and beliefs about teaching and learning frequently "outweigh" arguments that are made with relation to external priorities. External priorities were only found most in the form of outside expert viewpoints. In the second and third studies, these viewpoints especially concerned the appropriateness of having children use their own way of spelling words. In the second study, one teacher opposed the idea; in contrast, in the third study both the early literacy expert present and one of the teachers found such practice an important part of early literacy development.

Reflections

Nature of Design Talk

The studies presented provide insights into teachers' deliberative interactions in design talk, how design talk contains opportunities for learning, and content is manifested and utilized in design talk. This section reflects on the outcomes of this study in light of relevant literature on collaborative design and problem solving. Accordingly, the conclusions given above are taken as starting points in this discussion.

Brainstorms, Directed at Quickly Generating Solutions, Dominate Design Talk

The use of Walkers' SACD structured approach to curriculum deliberation framework revealed that the design process undertaken by the teachers in this study is mostly a process of brainstorming on possible learning activities. A brainstorm is an approach to solving problems by generating as many solutions as possible and then choosing the optimal solution or combination of solutions. Robust educational design recommends that potential solutions be tested and/or critically judged before selecting one or moving forward with any. In the studies presented here, teachers did not generate multiple solutions, but generated one solution of which the constituent parts were then brainstormed on. However, they did evolve their single idea until it was satisfactory. Design talk in this study closely resembles a solution-driven approach to solving design problems (Hong & Choi, 2011). The solution-driven approach as Hong and Choi (2011) characterize as an "iterative cycle of decision making" (p. 693). As they argue, designers make these decisions on the "constraints, criteria and functions of a design product" (p. 693). In the solution-driven approach, the definition of the problem emerges as the solutions are analyzed, evaluated, and criticized.

The solution-driven approach that was found in this study supports findings on how teachers collaborate in curriculum design. Teachers focus on the to-be-produced learning activities and learning material (Handelzalts, 2009; Kerr, 1981). Furthermore as Huizinga et al. (2014) concluded, teachers skip important and relevant design activities such as defining a problem or conducting an evaluation of initial ideas or draft material. This study portrays how, also from a micro-perspective, the focus remains on creating products.

There are several reasons for this finding. First of all, the design task that was given focused on creating a learning activity. This was done to ensure that teachers worked on a kind of task they already were familiar with. Also it helped teachers to provide them with a picture of the intended curriculum material. Second, teachers are naturally inclined to focus on concrete learning activities rather than on discussing abstract topics from subject matter. In the first study, the interview on the existing orientation regarding curriculum design showed that teachers already focused on designing concrete learning material. During design of PictoPal material, this inclination to designing learning material became even more apparent.

Conversations on Complex Problems Provide an Opportunity for Learning

Opportunities for learning present themselves during design talk when teachers traverse from sharing proposals on learning activities towards critical inquiry when making decisions or revisiting earlier-made ones. These reflections on action (Hong & Choi, 2011) may be considered contexts in which teachers learn, or at least they provide opportunities in which teachers may learn. Reflection has been considered a context in which teachers may develop knowledge (Bakkenes, Vermunt, & Wubbels, 2010).

The kind of knowledge that teachers learn through design appears to be in line with what Eraut (2007) calls *personal knowledge*. Such personal knowledge develops in interaction, and takes the form of "codified knowledge and/or shared meanings and understandings" (Eraut, 2007, p. 405). Teachers start with an initial idea of what kind of learning material should be designed. Initially, decision-making appears to be more intuitive than rational. Reflection triggers deeper conversations in which knowledge is made explicit. Hearing reasons given by others, and justifying one's own position, contributes to developing teacher personal knowledge.

In the design talk studied, teachers scarcely discussed their understanding of the design problem. It is possible that teachers felt this was clear to everyone and therefore required little clarification. However, this may also have to do with the fact that teachers' natural inclinations toward solving design problems are primarily intuitive in nature (Hoogveld, Paas, & Jochems, 2003). For design conversations to offer opportunities for teacher learning, not just the ideas, but also the reasoned decision-making of teachers must be discussed.

Substantive Support Provided by an Outside Expert Matters Most in Recommendations or Explanations

Huizinga et al. (2014) argue that TDT support should aim at updating teachers' subject-matter knowledge, their (technological) pedagogical content knowledge, and their design expertise, and their understanding of the reform. In this study, the outside expert was asked to participate naturally, and the contributions that directly influenced TDT decision-making were analyzed. The findings showed that the kind of support wielding influence on teacher decision-making was limited to recommendations and subject matter explanations.

Both the *form* and the *content* of the expert support provided were studied. The form of the support was aligned to the design process and responsive to the needs that teachers have, as recommended in literature (Huizinga et al., 2014). Such just in time support is expected to provide opportunities for learning. The information that the early literacy expert gave was provided was reactive as well as proactive. Reactive support was provided in response to needs expressed by the teachers; proactive support was provided at the early literacy experts' own discretion. In doing so, the information provided to teachers was closely aligned to their needs for subject-matter support.

Content knowledge that teachers need includes knowledge of domain-specific rules and principles, core concepts, and student misconceptions (van Driel, Verloop, & de Vos, 1998). The contents of the support given in this study included early literacy conceptual clarification, as well as ideas about how to foster early literacy in young children through PictoPal. Namely, the early literacy expert explained what specific concepts meant in early literacy and how these concepts related to the design problem that was currently under discussion. Also, the early literacy expert provided information on how kindergartners develop early literacy and how they reach certain goals. This information was aligned with teachers' needs to discuss

how vocabulary development was fostered. The early literacy expert provided detailed explanations of her viewpoints and relevant insights from contemporary research on vocabulary development. Finally, the support also contained ideas (provided during brainstorms) in terms of learning activities, which might be feasible and effective.

TPACK

The knowledge that teachers develop and use has been described as personal and situated in the context in which it is developed. As previously stated, the kind of knowledge that teachers may develop during "reflection-on-action" is personal knowledge. In the context of collaborative design, an important subset of personal knowledge that teachers use and develop is their existing orientations. Specifically, these existing orientations consist of teacher technological pedagogical content knowledge (TPACK) and design knowledge.

TPCK and TCK Are Mostly Expressed in Relation to Practical Concerns and Dominate the Content of Design Talk

TPACK has been conceptualized as the knowledge that teachers need to successfully integrate technology in classroom practice (Koehler & Mishra, 2005). This study has highlighted how teachers use TPACK in design by investigating if and when the three domains of pedagogy, technology and content are integrated during collaborative curriculum design talk. Findings showed that TPCK, the integration of the three knowledge domains, mainly took place in the context of practical concerns.

Teachers' perception and knowledge of the context influence TPACK development (Koehler & Mishra, 2008; Koh, Chai, & Tay, 2014; Voogt et al., 2013). In earlier studies, context knowledge has been conceptualized as knowledge of the classroom practice, the school system and the schools' vision of teaching and learning with or without technology; and the existing beliefs a teacher has gained through experience (Angeli & Valanides, 2009; Koh et al., 2014; Porras-Hernández & Salinas-Amescua, 2013). In this study, especially the contextual knowledge of classroom practice was linked to teacher use of TPCK. Teachers imagined what the learning material would look like and what kind of implementation related issues would be encountered (e.g., time, organization of activity, placement of material). Therefore, this study offers strong support for the notion that knowledge of context (especially foreseeing practical concerns) strongly relates to how teachers weave together their understanding of pedagogy, technology, and early literacy.

This study also found that teachers used their PCK for early literacy as a basis for the decisions they made regarding PictoPal. What this study therefore suggests is that teachers involved in this study integrated their technology knowledge with

their existing PCK. That is, despite new affordances of the technology, teachers were more focused on how it enabled them to do more of what they already did (without technology) in teaching early literacy. Koehler and Mishra (2008) suggest that there is reciprocity between the knowledge domains involved. Yet this study finds little support for that claim. One reason for this may be that teachers existing PCK already underlies most of their actions—with or without technology. Furthermore, for most teachers, technology use in kindergarten still somewhat novel and the affordances for this age group seem to be less apparent. The lack of understanding concerning the potential added-value for learning in kindergarten is likely a function of limited technological knowledge (as shown by the lack of T-codes in the conversations) and more widely held beliefs that (much) technology is inappropriate in kindergarten classrooms.

Teachers Rarely Explicate Content Knowledge in Isolation

Content knowledge was hardly discussed on its own; when it was discussed, it was in relation to setting the learning goals, discuss what current goals could be attained. Analysis of these portions of the conversation showed limited breadth and use of early literacy concepts. Teachers struggled with topics regarding early literacy or even held misconceptions about facts and principles in early literacy development. Teacher knowledge related to early literacy was more evident when connected with pedagogy. One explanation for this is the fact that primary school teachers (and especially kindergarten teachers) have been trained with more emphasis on pedagogy than on content. Building on this, their new knowledge likely enriches pedagogical knowledge and beliefs about learning, which is then applied to reach specific content-related goals. As a result, this study concludes that for these teachers, pedagogical knowledge (rather than teacher knowledge about content or technology), drives decision making in curriculum deign.

Research has shown that teachers' beliefs on teaching and learning influence how they integrate ICT in their classroom (Ertmer, 2005; Prestridge, 2012). In literature, kindergarten teacher beliefs about early literacy promotion have been related to how children were involved in early literacy activities (Burgess, Lundgren, Lloyd, & Pianta, 2001; Sverdlov, Aram, & Levin, 2014). In this study, the teachers' beliefs about teaching and learning clearly steered their decisions on how to promote early literacy. The teachers in this study valued engagement in written activities, making discoveries about literacy, using concrete material in play and collaboration to be the strategies most appropriate. Also, as this study showed, most teachers were inclined to focus these strategies on attaining vocabulary. This is likely because vocabulary development and understanding the link between letters and sounds was a learning goal that could be linked to current classroom practice as well as to future practice with technology.

Design Knowledge

Teacher Design Knowledge Is Mostly Expressed as Know-How, Yet Underpinned by Know-Why

Teacher design knowledge is the knowledge that teachers use to "engage skillfully in design" (McKenney et al., 2015). This study has provided a realistic account of how design knowledge emerges during design conversations. Teacher knowledge "incorporates aspects of personal expertise, practical wisdom and tacit knowledge" (Eraut, 2007, p. 406). While other studies on teacher knowledge have shown that personal knowledge does indeed underlie the decisions teachers make (Verloop, van Driel, & Meijer, 2001), this one focuses on the specific types of knowledge teachers draw upon when designing.

In the fourth study, the personal knowledge explicated in design talk was categorized as know-how (ways to shape learning materials and activities), know-why (principles, beliefs), and know-what (information, facts). The results showed that, while teachers differ in the kinds of design knowledge they express during design, the conversation was dominated by know-how. This was often related to addressing practical concerns. Indeed, the third study showed that teachers draw upon their integrated their knowledge (TCK and TPCK) to resolve practical concerns. This suggests that integrated technological pedagogical content knowledge might be a specific form of know-how, as both emphasize "knowledge in use" (cf. Koehler & Mishra, 2008).

External Priorities Feature Minimally in Teacher Design Talk

The finding that external priorities were hardly expressed in this study may be have to do with the context. Specifically, the role of some external priorities in shaping teachers' every day practice may be taken as given, and therefore not discussed. For instance, in the third study, one teacher stated that they worked from a developmental approach to kindergarten education (see Van Oers, 2003). This definitely influenced teacher views on the kinds of learning activities that are conducted in that school, but because this pedagogical vision is already understood and shared, there would have been no need to discuss it.

Another reason why external priorities may not have been addressed much in this study relates to the nature of the design task given. The PictoPal learning environment is clearly related to the national interim targets for early literacy. Additionally, teachers are already aware that the national language tests do not explicitly address the functions of written language. So, because the relationship between the designed PictoPal material and the (measured) attainment targets was clear from the start, there may have been little need to discuss if or how the design should be take such external priorities into consideration.

Recommendations

Recommendations for Practice

Based on the findings of this study, recommendations for practice are made for facilitators as well as for subject-matter experts that wish to provide procedural and substantive support to teachers. First, taking into account the solution-driven approach teachers employ in design, facilitators should encourage teachers to generate solutions but also guide them in critically evaluating these solutions. Facilitators can help by being aware of moments in design talk in which teachers struggle or when the decisions that teachers do not seemed to have been thought through. At such moments, facilitators could pose questions that require teachers to step back from the ideas/decisions, and elicit teachers reasoning (draw out their know-why).

Second, subject-matter support should be aligned with teachers' natural inclinations during design. This study showed that teachers reason from their pedagogical knowledge and beliefs and that they used extended subject-matter expertise when it was offered in the forms of recommendations and explanations. Teachers appreciated having the outside subject-matter expert serve as co-designer, sharing knowledge not in isolation, but in direct connection to the design problem at hand. To share knowledge in use and serve where needed, technological pedagogical content expertise (as opposed to only content expertise) would likely be most helpful to teachers.

Third, related to developing teachers' integrated technological pedagogical content knowledge, it is recommended that facilitators explicitly support teachers in thinking through the actual use of the design, even in early stages before it is constructed. This is because conversations in which teachers envisioned actual use appeared to draw out their integrated technological pedagogical content knowledge. During such conversations facilitators can expect two kinds of practical concerns: design-related (What should the products look like?) and implementation-related (How should the product be used?). Additionally, facilitators should prepare for and prompt conversations related to both (e.g., what characteristics the product must have to enable a certain kind of use).

Recommendations for Future Research

Based on the experiences from this study, several recommendations for further research are presented to further investigate collaborative design of technology-rich learning. First, to gain a more complete picture of the knowledge teachers use during design, their products could be investigated. This could be done by means of appraisals from early literacy experts and experts on technology. Additionally, insight into the design could also be gained by studying implementation of the products through observations during or interviews directly after use.

Second, to further explore how collaborative design forms a context for teacher learning, subsequent research should follow teachers through multiple cycles of action and reflection. Such cyclical learning is considered a key aspect of teacher learning (Clarke & Hollingsworth, 2002) in general and in collaborative design teams especially (Voogt et al., 2015). Such a longitudinal study would examine teacher learning as a result of initial design; implementation; reflection on action; reflection on consequences (learner experience and performance) as well as redesign.

Third, this small-scale study involved a limited number of participants. Replicating this study in other kindergarten contexts (e.g., more variety in school types, in other countries) would help ascertain the extent to which the findings from this study could be generalizable. In so doing, attention should be given to not only the teacher designers, but also the kinds of contributions by facilitators and/or subject-matter experts that influence the decisions teachers make and the (quality) of the material designed.

Closing Comments

This study has described the nature and content of teacher design talk when centered on technology-rich learning materials for early literacy. It has showed the kinds of knowledge teachers use and has demonstrated that design conversations can provide opportunities for learning. The implications for practice and future research were discussed. According to Fullan (2007), educational innovation rests on what teachers think and do. Through detailed investigation of teacher talk, this study has revealed how teachers reason together and what drives their decision-making during the design of innovative learning material.

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