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Teacher involvement in curriculum design: need for support to enhance teachers' design expertise

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Teacher involvement in curriculum design has a long tradition. However, although it fosters implementation of curriculum reforms, teachers encounter various problems while designing related to conditions set for the design process, and lack the knowledge and skills needed to enact collaborative design processes. Providing support to enhance teachers' design expertise is essential, since most teachers are novice designers. However, little is known about the nature of the support offered to improve teachers' design expertise. In this explorative study, six teachers and six facilitators offering support reflected on an enacted design process, the problems they experienced and the support offered. The findings indicate three gaps in teachers' design expertise related to three domains (1) curriculum design expertise, (2) pedagogical content knowledge and (3) curricular consistency expertise. The outcomes of this study illustrate the importance of supporting teacher designers during the design process and enhancing teachers' design expertise. By offering (tailored) support to teachers, the enacted design process and the quality of the design materials are expected to improve.

Keywords: curriculum design; design expertise; teacher designer; teacher as curriculum maker

Introduction

The success of curriculum reforms largely rests on the shoulders of teachers, since they are the ones who put reform ideas into practice. Successful implementation of reforms depends on teachers' ownership of and their knowledge about reform ideas (Handelzalts 2009, Kirk and MacDonald 2010, McKinney and Westbury 1975). Involving teachers from the early stages of curriculum design fosters ownership (e.g. Bakah *et al.* 2012,

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Carlgren 1999, Handelzalts 2009). The need to involve teachers in curriculum design was realized after failures to implement teacher-proof curricula during curriculum reforms in the 1940–1970s (McKinney and Westbury 1975, Stenhouse 1975). Since the mid-seventies scholars (e.g. Green 1980, Stenhouse 1975) have discussed the importance of involving teachers in the design process, to provide teachers with 'the opportunity to experience the practical alternatives [and] to make their choices' (Green 1980: 7). It resulted in (school-based) curriculum development projects in which teachers fulfilled the designer role (Eggleston 1980, Skilbeck 1984). However, these early efforts were poorly supported and structured and teachers lacked the knowledge and skills to enact the design processes (Eggleston 1980, Walker 1975). It was expected that by inviting teachers to collaborate in teams during the design process, knowledge and skill-related limitations could be dealt with (e.g. Craig 2009, Crow and Pounder 2000, Parke and Coble 1997). Collaboration creates opportunities to exchange experiences and expertise (Handelzalts 2009, Havnes 2009, Peterat 1993, Walker 1975). Moreover, a shared operational understanding of the curriculum reform and its implications might help to create ownership, and a more realistic implementation strategy (e.g. Elizondo-Montemayor *et al.* 2008).

Despite the advantages of designing curricula in teacher teams, further referred to as 'teacher design teams' (TDTs), some challenges still exist. Next to practical challenges (e.g. limited time) and dealing with the variation in expectations within the team, teachers in TDTs often lack design expertise (Bakah *et al.* 2012, Handelzalts 2009, Havnes 2009, Vescio *et al.* 2008). A lack of design expertise affects the enacted design process and eventually the quality of the designed curricula (Hardré *et al.* 2006). In order to reduce design expertise-related problems support is often offered to TDTs (e.g. Bakah *et al.* 2012, Cumming 2011). Many studies report about support geared towards developing teachers' subject matter knowledge and pedagogical content knowledge (e.g. Cumming 2011, Da Ponte 2012), whereas only a few studies pay attention to the support to increase teachers' design expertise (e.g. Hoogveld 2003). Since design expertise is crucial for enacting successful design processes, insights into teams' difficulties in curriculum design are required. Combined with articulated needs for support, such insights can be used for designing quality support for TDTs.

The Dutch context offers a prime opportunity to explicitly study TDTs' difficulties in designing curricula and their needs for support related to design expertise. In 2006, new attainment targets were introduced for lower secondary education in the Netherlands (12–14-year-olds). The formulation of the 58 attainment targets was at a very generic level. It was expected that these would be operationalized and adapted to school contexts. Approximately 60% of all schools in lower secondary education gave teacher teams a key role in the (re)design of their curriculum (Onderbouw-VO 2009). TDTs had to make decisions about what and how content was offered to their learners, which resulted in distinct courses and/or interdisciplinary courses (Onderbouw-VO 2009).

The purpose of this study was to identify the needs of and support for TDTs to develop design expertise required to design lesson series for interdisciplinary courses. In this study, lesson series refer to a series of related lessons about the same topic of theme. Curriculum materials, such as lesson series, represent the operationalized curriculum reform and, therefore, play an important role during the design of curriculum reforms (Thijs and Van den Akker 2009). The question that guided this study was *What are lower secondary education TDTs' needs for support during collaborative design of lesson series?* In answering this question specific attention was paid to teachers' curriculum design expertise needed to enact the design process. In this study, teachers' need for support to enhance teachers curriculum design expertise was investigated from two perspectives. First, the knowledge and skills-related problems teachers experience while designing indicate which support is needed. Second, support offered to TDTs also provides information about required support for TDTs while designing. Therefore, the main question was divided into two sub-questions, namely:

(1) Which problems related to a lack in design expertise do TDTs experience when they collaboratively design lesson series?
(2) What support do TDTs receive to acquire the design expertise required to collaboratively design lesson series?

Defining teachers' design expertise

To be able to identify the support that is needed to enhance teachers' design expertise, we first elaborate on what design expertise is. The expertise required to enact curriculum design has been described by various scholars (e.g. Forbes 2009, Hardré 2003, Hardré *et al.* 2006, Huizinga 2009, Nieveen and Van der Hoeven 2011, Richey *et al.* 2001, Seels and Glasgow 1991). They use different labels to describe elements of the same concept, including *curriculum design competencies* (Huizinga 2009, Seels and Glasgow 1991), *instructional design competencies* (Richey *et al.* 2001) and *design expertise* (Hardré 2003, Hardré *et al.* 2006). In this study, the term design expertise is used. Design expertise consists of the knowledge and skills to enact a design process. It prescribes analysis, design, development, implementation and evaluation skills (e.g. Eggleston 1980, Richey *et al.* 2001, Seels and Glasgow 1991). However, teachers are not only expected to be able to enact the design *process*, but as Schwab (1973 in Ben-Peretz 1990) points out, they are also required to have substantial knowledge and skills such as subject matter knowledge and insights into the learners, the teachers and the context.

Based on a literature review, Huizinga (2009) developed an overview of the design expertise teachers need in order to be able to design lesson series. Two types of design expertise were distinguished, namely *generic design and process expertise* and *specific design expertise*. Generic design and process expertise refers to knowledge and skills for enacting design

processes in general, while specific design expertise refers to the knowledge and skills required for developing curricula (in this case lesson series). Both types of design expertise are required in order to successfully enact a design process. Figure 1 provides the overview of design expertise required to design curricula. In this study, the focus is on the *specific design expertise*, since previous studies indicate that most knowledge and skills-related problems relate to the process of curriculum design (e.g. Handelzalts 2009, Hoogveld 2003). Therefore, this study focuses on identifying the support needed to develop teachers' knowledge and skills in specific design expertise, that is, curriculum design expertise, subject matter knowledge, pedagogical content knowledge and curriculum consistency expertise. The specific knowledge and skills of these four categories will be described in the next section.

Curriculum design expertise

The knowledge and skills required to enact curriculum design are addressed as *curriculum design expertise* (Dick *et al.* 1985, Gustafson and Branch 2002, Hardré 2003, Huizinga 2009, Lunenberg 2002, Richey *et al.* 2001, Seels and Glasgow 1991). Curriculum design consists of analysis, design, development, implementation and evaluation activities, which are operationalized in specific tactics. Six types of knowledge and skills, based on activities in existing curriculum and instructional design models, are identified as relevant for teachers for enacting design processes (Huizinga 2009):

(1) Knowledge and skills to formulate a problem statement
(2) Idea generation skills
(3) Systematic curriculum design skills
(4) Formative and summative evaluation skills
(5) Curricular decisions-making skills
(6) Implementation management skills

Design processes usually start with determining *what* is being designed. Therefore, teacher designers are expected to formulate the aim of the project and identify the problem that needs to be tackled (Crain

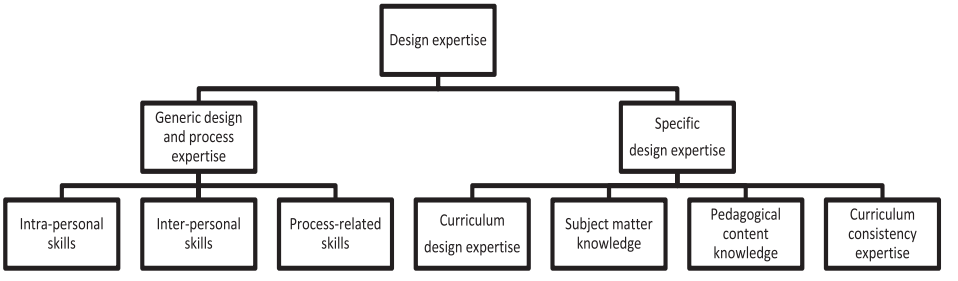

Figure 1. Teachers' design expertise overview (Huizinga 2009).

et al. 1995, Lunenberg 2002, Richey *et al.* 2001). Furthermore, various ideas have to be generated in order to tackle the identified problem (Crain *et al.* 1995). During the design process itself teachers are expected to systematically apply tactics to tackle the problem, by making well-founded decisions (based on insights from theory and practice), evaluating the relevancy, consistency, practicality and effectiveness of the curriculum materials (Thijs and Van den Akker 2009) and by implementing the curriculum materials in practice (Gustafson 2002, Kerr 1981, Kessels 1999, Lunenberg 2002, Richey *et al.* 2001, Seels and Glasgow 1991).

Subject matter knowledge

Curriculum materials are expected to represent accurate, relevant and up-to-date insights of the subject matter knowledge. Therefore, teacher designers should have sufficient knowledge about the course they offer and enact strategies to keep this knowledge up-to-date (Brandes and Seixas 1998, Davis and Krajcik 2005, Nelson and Orey 1991, Richards 1991). Two types of knowledge and skills related to subject matter knowledge for designing curriculum materials are identified by Huizinga (2009) as relevant for teacher designers, namely:

(1) Knowledge and skills to keep subject matter knowledge up-to-date
(2) Knowledge and skills to gain insights into learners' subject matter knowledge difficulties

Teachers apply various strategies to keep their subject matter knowledge accurate and up-to-date, for instance, by collegial consultation, reading professional and/or scientific literature and attending conferences (Huizinga 2009, Kessels 2001). Furthermore, teachers are expected to apply this newly acquired knowledge, when relevant, to curriculum materials. In addition to keeping the subject matter knowledge up-to-date, teacher designers have to become familiar with the difficulties learners have regarding the subject matter knowledge and *why* learners experience these difficulties (Angeli and Valanides 2009, Kreber and Cranton 2000, Marks 1990, Richey *et al.* 2004). These insights can be used to design materials that effectively support learners in their learning process.

Pedagogical content knowledge

Including accurate and up-to-date subject matter knowledge in curriculum materials is not necessarily sufficient to foster the learning process. Therefore, teacher designers need to decide which approaches to teaching and learning they promote in the materials. Shulman (1986: 9) defined this as pedagogical content knowledge, 'which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge *for teaching*'. Three types of knowledge and skills are distinguished for teacher designers, namely:

(1) Pedagogical repertoire
(2) Material selection skills
(3) ICT selection skills

The pedagogical repertoire addresses teachers' knowledge and skills to select, apply and include relevant pedagogical strategies to offer the subject matter (Cochran *et al.* 1991, Marks 1990, Shulman 1986, 1987), which is used to select appropriate materials which represent the course-specific pedagogy (Barrows and Kelson 1993, Verloop and Lowyck 2003). Furthermore, teacher designers are expected to determine whether the use of ICT is beneficial for offering the subject matter and to select and integrate appropriate ICT-based materials in the lesson series they are designing (e.g. Angeli and Valanides 2009, Koehler *et al.* 2007).

Curriculum consistency expertise

During the design process, teachers need to design materials which are consistent. The consistency of curricula refers to internal consistency and external consistency (Kessels 1999). Two types of specific knowledge and skills are distinguished in order to develop consistent curricula:

(1) Knowledge and skills to create internally consistent curricula
(2) Knowledge and skills to create externally consistent curricula

Internal curriculum consistency describes the balance and coherence of curriculum elements (e.g. as described by Van den Akker 2003) and the alignment of the curriculum with the school's vision, their students and demands from society. Teacher designers should be able to create materials which are well balanced and well aligned. External curriculum consistency concerns the coherence of perceptions of the involved teachers and relevant stakeholders (e.g. school's management and non-involved teachers) on what the problem is and how to tackle it (Kessels 1999). External consistency is achieved by applying a relational approach during the process, which implies involving teachers and relevant stakeholders during the early stages of the design process and, therefore, revealing their perceptions of the expected outcomes and how this can be achieved (Handelzalts 2009, Hord 2004, Kessels 1999).

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, Odenthal 2003, Stenhouse 1975). However, how to support teachers is less clear, or as Nieveen *et al.* (2005: 22) indicated 'there is no single best way in the innovation process', which caused a dilemma for the facilitators 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 of the role of the facilitators (Nieveen *et al.* 2005, Odenthal 2003). 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, which 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 in the form of specific workshops or training sessions to foster teachers' subject matter knowledge, pedagogical content knowledge and/or curriculum design expertise are offered (Bakah *et al.* 2012, Garet *et al.* 2001, Hardré *et al.* 2006, Nieveen *et al.* 2005). Workshops and training sessions are offered with specific predefined aims or learning goals. Since such support is offered in various context and is evaluated, the quality and effectiveness of the support is 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 support offered to design teams. Facilitators can offer pro-active and re-active support (Nieveen *et al.* 2005). When offering pro-active support, facilitators help steer the team during the design process (e.g. outlining the process) and make sure that teachers don not skip important design activities (e.g. conducting evaluations). In contrast, when offering re-active support, facilitators follow the team's enacted design process and react on the decisions made and make sure that all important design activities are enacted. Both during re-active and pro-active support facilitators determine the support based on the articulated needs for support by the teams. Given the various expectations of the support and preferences of teachers within teams, balancing pro-active and re-active support seems essential for the design process (Nieveen *et al.* 2005, Odenthal 2003).

Methods

The aim of this study was to identify TDTs' needs for support to increase their design expertise by answering the research questions as stated at the end of the introduction section. Both teachers and facilitators were interviewed on the enacted design process of locally designed lesson series. This design process took place within the context of a large-scale curriculum reform. Interviews were conducted to explore teachers' design expertise and the provided external support while designing. A qualitative approach was applied to reconstruct the design process allowing for additional questions regarding the design process and the corresponding

need for support. The study can be characterized as a cross-sectional qualitative study, since teachers' needs for support were described from two perspectives (teachers and facilitators). Their perspectives were analysed and compared in order to triangulate the data (Patton 1987).

Respondents

Purposeful samples of six teachers and six facilitators were selected (Patton 1987). A two-stage process was applied to select the teachers. First, schools were selected which offered interdisciplinary courses. Second, within the selected schools, teachers who had experience with designing course materials for these interdisciplinary courses were approached. Table 1 shows the characteristics of the interviewed teachers, the aim of their design process and the received support during the design process.

For selecting the facilitator, a similar two-stage process was applied. First, six organizations which offer support to TDTs were selected to participate in this study. Second, within each organization, one facilitator was selected based on the experience of supporting TDTs who designed interdisciplinary courses. 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. Table 2 shows the facilitators' characteristics and the key characteristics of the TDTs they supported and of the support itself.

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, involved subjects, 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 offered support activities 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 check (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

Table 1. Characteristics of the teachers.

Teacher	Teaching experience (years)	Design experience (years)	Role within design team	Team size	Involved subjects	Aim of the project	Developed materials	Received external support
TA	20 years	8	Project manager and designer	8 (2 per school)	Various subjects (e.g. social sciences, English)	Creating digital materials to suit the wishes of the involved schools	Digital materials for various subjects	Curricular framework to order and align the materials
TB	4 years	4	Designer	Approximately 10 teachers	Social sciences	Creating interdisciplinary courses that suit the new school context	Activity cards	Coaching and facilitating the process
TC	2 years at current school	2	Designer	6	Economics, history and geography	Creating interdisciplinary courses	Projects and learner materials	None
TD	6 years	2	Designer	2	Sociology	Creating an interdisciplinary course based on themes (e.g. politics)	Various types of learner materials including textbooks and assignments	None
TE	25 years	3	Designer	3 (together with TF)	Social sciences and Dutch	Fostering the implementation of laptops	Digital curriculum materials and projects	Feedback on the quality of the materials
TF	11 years	4	Designer	3 (together with TE)	Social sciences and Dutch	Fostering the implementation of laptops	Digital curriculum materials and projects	Feedback on the quality of the materials

Table 2. Characteristics of the facilitator.

Facilitator	Experience as facilitator (years)	Size of the team that was supported	Involved subjects	Aim of the supported project	Developed materials by the teachers
SA	12	3	Geography and history	Creating and implementing interdisciplinary courses	Interdisciplinary projects and learner materials
SB	10	30	Unknown	Implementing interdisciplinary courses and new pedagogies	Experience with new pedagogical insights
SC	1.5	All teachers of one school	Social sciences and other interdisciplinary courses	Implementing culture-oriented education (COE) for all courses	Learner materials that suited the COE vision
SD	9	All teachers of social sciences	Geography, history and economics	Implementing four interdisciplinary courses, focus on social sciences	Activity cards (learner tasks)
SE	3	n.a.	n.a.	Development of online repository for curriculum materials	Arrangement of existing curriculum materials
SF	13	30	Social sciences	Implementing 'green' education in a school for vocational education	Learner materials

the interview guides, codes were created based on the extended theoretical framework. The codes referred to the design expertise-related problems TDTs experienced. Table 3 shows examples of specific codes that were developed, the description of the code, on which research insights the codes were based and one example quotation to which it was applied.

Inductive coding was applied in order to identify the support activities offered to tackle experienced problems and those activities offered to address teachers' needs (Table 4). In addition, inductive coding was applied to retrieve additional insights regarding the 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

Table 3. Examples of deductive coding of the summaries.

Code	Related knowledge and skills	Description of code	Code based on	Example quote
Received-support-consistency	Curriculum consistency expertise	Description of a support activity that addresses the internal or external consistency of the lesson series	Kessels (1999), Van den Akker (2003)	'It is about the assessment, the alignment, learning in the context, the interdisciplinary nature and stuff like that'.
Feedback-teachers	Curriculum design expertise	Description of how teachers gave feedback on each other's lesson series	Dick *et al.* (1985), Hardré *et al.* (2006), Lunenberg (2002)	'I always give it [lesson series] a Dutch teacher … he checks for spelling mistakes'.
Support-most-valuable	All categories	Description of the support activities that teachers found the most valuable	Handelzalts (2009), Loucks-Horsley *et al.* (1998), Odenthal (2003)	'It was a one-day workshop, in which we received the template that we still use'.
Support-additional-process	Curriculum design expertise	Indication of the need for additional support during the design process	Dick *et al.* (1985), Handelzalts (2009)	'Starting and finalizing tasks. This could be improved by setting strict deadlines'.
Support-offered-by-agency	All categories	Description of the support that is offered by an agency	Handelzalts (2009), Loucks-Horsley *et al.* (1998), Odenthal (2003)	'It has to be a substantial trajectory, in which questions are posed related to curriculum development and the subject matter'.

Table 4. Examples of inductive coding of the transcriptions.

Code	Related knowledge and skills	Description of code	Example quote
Concrete examples/ school visits	Curriculum design expertise Curricular consistency expertise	Support offers concrete examples (e.g. exemplary materials) or visits other schools with the teacher team	'We developed exemplary materials and offered in on our website'.
			'I offer a lot of examples and use my experiences with supporting other schools'.
Support activity	All categories	General description for support offered. Made concrete by using a second code (e.g. *shared vision*)	'Specifically with the teachers of the interdisciplinary domain, we let them think about how to deal with the content and how they are going to offer it'.
Experienced problems	All categories	Description of the problems experienced during the design process. Made concrete by using a second code (e.g. collaborative enactment)	'It is difficult to have the same pace in an interdisciplinary course as a colleague of a different [individual] course'.

the coding done by the first author of this paper. 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, three out of twelve interviews were re-coded by the research assistant, which led to an acceptable inter-rater reliability (Krippendorff's Alpha) of 0.72.

Findings

Table 5 shows which design expertise categories were discussed, which specific knowledge and skills were addressed and how many respondents discussed it (represented with '($n = x$)').

In the subsequent sections, the specific design expertise will be discussed in more detail, starting with curriculum design expertise.

Curriculum design expertise

All respondents reported on teachers' curricular design expertise in detail (Table 6). In general, teachers faced an ill-defined vision about their future classroom practice and therefore had various expectations within the team about the project's outcomes. Furthermore, support was offered to TDTs for the creation of a curricular framework or (lesson-specific)

Table 5. Categorical overview of design expertise addressed in interviews.

	Specific design expertise			
	Curriculum design expertise	Subject matter knowledge	Pedagogical content knowledge	Curriculum consistency expertise
Teachers ($N = 6$)	Problem statement ($n = 3$)	Up-to-date knowledge ($n = 4$)	Pedagogical repertoire ($n = 2$)	Internal consistency ($n = 4$)
	Systematic Design ($n = 5$)	Insights in learner difficulties ($n = 4$)	Material selection ($n = 5$)	External consistency ($n = 3$)
	Formative and summative evaluation ($n = 4$)		ICT selection ($n = 3$)	
	Decision-making ($n = 4$)			
	Implementation ($n = 6$)			
Facilitators ($N = 6$)	Problem statement ($n = 2$)	Up-to-date knowledge ($n = 4$)	Pedagogical repertoire ($n = 4$)	Internal consistency ($n = 2$)
	Systematic Design ($n = 3$)	Insights in learner difficulties ($n = 2$)	Material selection ($n = 2$)	External consistency ($n = 4$)
	Formative and summative evaluation ($n = 2$)			

Table 6. Overview of teachers' curriculum design expertise.

	Problem statement	Systematic design	Decision-making	Formative and summative evaluation	Implementation
Teachers ($N = 6$)	- Ill-defined shared vision about the future practice (TA, TC & TD)	*IA* No specific problems (TA, TC, TE & TF) + Use of templates (TA, TB, TE & TF) - Organizing materials in a well-considered order (TA)	*IA* Practical usability discussed (TA, TB, TE & TF)	+Evaluation enacted with peers (TA, TD, TE & TF) - Quality questions of individual and combined materials (TE & TF) *SO* evaluation criteria (TE & TF)	*IA* Materials implemented (TA, TB, TC, TD, TE & TF) - Implementation hindered by context-related problems (TB & TC)
Facilitators ($N = 6$)	- Ill-defined shared vision about the future practice (SA & SF)	*SO* Resources to design digital materials (SE) *SO* support with construction of curricular framework (SC, SD & SE) *SO* Templates (SC & SD)	Not addressed	- Unfamiliar with evaluation activities (SC & SF) *SO* feedback on materials (SC & SF)	Not addressed

Explanation of symbols (also for subsequent tables): Teachers' experienced problems '-'; Teachers' knowledge and skills were a catalyst '+'; Teachers addressed the issue without a judgment 'IA'; Support offered to enhance' teachers' knowledge and skills 'SO'.

templates. This might imply that teachers require additional knowledge and skills to align single lessons or activities in a well-considered order. Finally, the enactment of evaluations was also supported to enhance the design process.

Four teachers (TA, TB, TE & TF) reported that the use of templates fostered their design process. They were more aware of stating the lesson series' goals and focusing on the content and not on the specific layout (TA). Two teams (TA's and TB's team) discussed the layout of the lesson and created a template that included the decisions made. Two facilitators (SC & SF) collaboratively designed templates with TDTs they supported and discussed with the teachers *how* the intended goals of the reform could be achieved.

Whereas templates were used for the development of individual lessons, teachers in TA's team also articulated the need for a curricular framework. They contacted the national institute for curriculum development for such frameworks and used these (externally designed) frameworks to align the individual lessons in a well-considered order. Three facilitators (SC, SD & SE) also argued that teachers require curricular frameworks for the alignment of individual lessons. Surprisingly, none of them reported that they offered such frameworks to TDTs.

Finally, although four teachers indicated that they evaluated the materials developed with their peers (TA, TD, TE & TF), conducting an evaluation remains difficult. TE and TF, who collaborated in a team, received support to make them more aware of quality criteria and the enactment of evaluations. SC argued that teachers raised questions such as 'Do we cover the attainment targets?' and 'How can we easily develop quality materials?'

Subject matter knowledge

None of the respondents reported major problems related to subject matter knowledge (Table 7). This implies that teams had sufficient knowledge to design the lesson series, which might indicate that no specific support is needed on this issue.

Although no major problems were reported, one team (TE/TF's team) experienced a minor problem when one of the involved subject matter teachers left the TDT. They tackled this problem to involve this teacher in the evaluation activities. One facilitator (SA) supported TDTs by visualizing the subject matter's overlap with a Venn diagram to determine which content was included in the lesson series.

Pedagogical content knowledge

Both teachers and facilitators indicated that TDTs had sufficient pedagogical content knowledge to design lesson series. Sometimes support was offered to enhance teachers' pedagogical content knowledge related to the interdisciplinary character of the lesson series (see Table 8). Furthermore,

Table 7. Overview of teachers' subject matter knowledge.

	Up-to-date subject matter knowledge	Insights into learners' subject matter knowledge difficulties
Teachers ($N = 6$)	*IA* No problems occurred (TA, TC, TD & TE)	*IA* In general sufficient insights (TA & TC) - If subject matter experts leave team, problems can occur (TE & TF)
Facilitators ($N = 6$)	*IA* No problems experienced (SA, SC, SD & SE)	*IA* No problems experienced (SA & SE)

Table 8. Overview of teachers' pedagogical content knowledge.

	Pedagogical repertoire	Material selection	ICT selection
Teachers ($N = 6$)	*IA* In general sufficient - Problems selecting pedagogy for inter-disciplinary courses (TA & TE)	+Criticizing materials (TA, TC, TD, TE & TF) - Not adapting materials (TA, TC, TD, TE & TF)	- Too little experience at first (TA, TE & TF)
Facilitators ($N = 6$)	*SO* New pedagogical insights offered to teachers (SA, SB, SC & SD)	*SO* Questions how to select materials (SD) *SO* Background information about searching and selecting (SE)	Not addressed

the results suggest that support is required when TDTs include a new pedagogical approach in existing materials. Thus, it seems that in some specific cases teachers' pedagogical content knowledge is insufficient.

In addition to posing questions (SA & SC), SB organized workshops in which teachers and learners experienced a new pedagogical approach. Afterwards, SB reflected with teachers and learners on the pros and cons of the new pedagogical approach.

Teachers hardly considered the usage of existing (teacher-made) materials, since they were very critical about the applicability of the material they found online in their own context. Yet none of the teachers indicated that they adapted the materials, which might imply that they lack the required (technical) skills to adapt (digital) materials. TE and TF commented on the usage of existing materials:

> TE: 'Assignments were too lengthy or boring or did not address our needs'.

> TF: 'The materials did not fit our needs; we could not say we can use these [in our own materials]'.

Curriculum consistency expertise

Teachers and facilitators reported problems related to achieving internally and externally consistent lesson series, especially regarding the quality of the lesson series and the team's shared vision (Table 9). Therefore, helping TDTs from the start to develop a shared vision seems vital to enhance the overall design process. Subsequently, the shared vision can, during a later stage of the design process, be used to evaluate the lesson series and to achieve internal consistency.

The example of TE/TF's team illustrates the concerns teachers had with the materials they designed themselves. During their design process, they contacted an external facilitator to evaluate the quality of the designed lesson series; the facilitator provided them with feedback on the designed lesson series. Furthermore, he discussed with the TDT how to cover the attainment targets, which made TE and TF more aware of the attainment targets. Finally, he gave the team a checklist to evaluate the lesson series, which they still use. Two facilitators (SA & SC) reported that they helped TDTs to reflect on how to improve the quality of the lesson series, especially related to alignment with the attainment targets.

In their challenge to reach external consistency, TDTs faced several problems developing a shared vision. These problems occurred since there was no consensus regarding the outcomes of the design process and teams lacked a shared understanding of the main concepts they wanted to include in the lesson series. Consequently, it hindered the teams' design process (TB & TD). External consistency was achieved by discussing in-depth with the teams how the new materials would be applied in their future practice. The discussions were used to elicit the teams' shared vision that guided the design of, for instance, the activity cards (TB) and learner materials (TD). Also, facilitators discussed that TDTs experienced difficulties developing a shared vision. SC discussed with the teacher team what each member understood with their main concept and she used this input to visualize the team's discussion. During the discussion, SC posed

Table 9. Overview of teachers' curriculum consistency expertise.

	Internal consistency	External consistency
Teachers ($N = 6$)	- Quality of the curriculum materials, including alignment with attainment targets (TA, TB, TE & TF)	+Shared vision fosters design process (TA, TB & TD) - Problems during development of shared vision (TA, TB & TD)
Facilitators ($N = 6$)	- Quality of the curriculum materials, including alignment with attainment targets (SA & SC)	- Teams lack a shared vision (SA, SC, SD & SF) *SO* Reflection and discussion foster development of shared vision (SA, SC, SD & SF) *SO* Interpretations of key concepts (SA, SC & SF)

questions, such as 'What does this mean for the curriculum?' and 'What does this [aspect addressed in discussion] mean for the concept [culture oriented education]?' SA argued that teachers have to 'conceptualize the aim of the reform and why teachers want to achieve this'. He let teachers describe their ideal future practice and tried to align these descriptions.

Conclusion and discussion

This study explored gaps in teachers' design expertise required for designing lesson series. These insights can be used to design and offer support during design processes. Prior research already indicated that teachers require support to tackle design-related problems during design processes (e.g. Ben-Peretz 1990, Nieveen *et al.* 2005, Odenthal 2003, 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 from the experienced problems and support offered to overcome the problems.

Curriculum design expertise

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

Facilitators also recognized TDTs' problems with creating the problem statement. Therefore, they offered support to TDTs to develop the teams' shared vision about the 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 strongly articulate the importance of enacting a systematic design processes and enacting evaluation activities (Hardré *et al.* 2006, Richey *et al.* 2001, Seels and Glasgow 1991), since it is beneficial for the quality of the designed product (Gustafson 2002). However, teachers hardly 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 hardly performed analysis activities, such as a learner or context analysis. In contrast to Handelzalts (2009: 208), who argued that teachers 'are not inclined to initiate evaluation activities of any sort', the teachers in this study enacted 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 made (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 where not involved in the initial stages of the design process. While supporting the design and evaluation stage facilitators reflected with the team on the 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 the materials' layout. Similar support was offered to conduct evaluation activities, since facilitators provided checklists, feedback or learned 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 explorative study, it seems essential to support TDTs especially during the analysis stage and evaluation stages since they experience 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 in offering interdisciplinary courses (cf. Krajcik *et al.* 2007).

Facilitators offered some insights in 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 *et al.* 2012), which indicate the essence of collaborative learning and the connection to teachers' classroom practice, the offered pedagogy-related support seems beneficial for increasing teachers' pedagogical repertoire. In addition, Handelzalts (2009) noted that helping teachers to visualize the future practice by

piloting, conducting school visits and discussing blueprints can also be added to enhance teachers' understanding of new pedagogy.

Teachers' ability to select materials suiting the selected pedagogy has been identified as a part of teachers' pedagogical content knowledge for designing (e.g. Huizinga 2009, Nieveen and Van der Hoeven 2011). During the design of lesson series, teachers select and often adapt the materials found to their own context (Remillard 2005). Teachers in this study criticized the materials found in digital repositories on their practical usability and did not use the materials. Instead, they used the repositories to get inspiration. A reason might be that teachers lack the *technical* skills to make the required adaptations to the digital materials (cf. Wilhelm and 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 teacher designers in the study of Strijker and Corbalan (2011). Their study illustrated that it improved the search process and that the found materials 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 in order to design teaching materials. The integration of ICT required that teachers are familiar with ICT and able to make adjustments in order to fit it in 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 explorative study, it seems helpful to offer some technical support to teachers to make contextual adaptation to digital materials found on repositories. This prevents that valuable time is lost in creating materials which are already available.

Curricular 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 internally consistent lesson series was already partly discussed in the previous sections (e.g. templates and helping to conduct evaluations). Teachers felt insecure about the materials' quality, which they partly tackled by using templates. Yang *et al.* (2006) also argued that templates are useful to prepare high-quality curriculum materials. For the design of lesson series, they also articulated the need for curricular frameworks to organize the individual materials in a well-considered order. Yet facilitators hardly offered such frameworks, despite their indications 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 initialized 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.

Limitations

The small-scale nature of this study might limit the scope of the findings of the study. Teachers and facilitators volunteered to participate in the research and might have experienced the design process differently than their colleagues. This limitation was partly tackled by comparing the results with insights from prior research. A second limitation is that both groups of respondents reflected on the design process. The reflection on the process might have been influenced by the feeling of success or failures after implementing it in practice.

Recommendations

The results of this study underline the importance of supporting TDTs in the process of creating internally and externally consistent curriculum materials. Furthermore, the study illustrates which support TDTs require related to categories of teachers' design expertise when designing lesson series. This study resulted in three guidelines for supporting TDTs' curriculum and instructional design processes aiming to design lesson series. First, to enhance the quality of the curriculum design process support should be offered just-in-time as an integrated part of the design process to enhance teachers' design expertise (cf. Garet *et al.* 2001, Nieveen *et al.* 2005, Van Driel *et al.* 2012). Support offered just-in-time fosters the enacted design process. In addition, such support offers professional learning opportunities for teachers to further develop their design expertise. Through just-in-time support, teachers can directly apply the new knowledge and skills gained in the design process.

Second, support should focus on developing teachers' curriculum design expertise, pedagogical content knowledge and curricular consistency expertise. The results of this study illustrate that both teachers and facilitators indicate that teachers experience lack of expertise in these

domains, which can be tackled by offering support. Since teachers face knowledge and skills-related problems throughout all stages of the design process the quality of the curriculum design process will be improved if support to enhance teachers' curriculum design expertise, pedagogical content knowledge and curricular consistency expertise is offered from the early stages of the design process.

Third, the results of this study indicate that templates, curricular frameworks and evaluation guidelines are essential tools to support teachers in the design of quality lesson series. TDTs question the quality of the designed lesson series, by offering concrete support such questions can be addressed.

This study contributed to knowledge about the support teachers need to design quality lesson series to foster enactment of curriculum reform. Follow-up research is required to explore the applicability of the guidelines in other contexts in which curriculum and instructional design is conducted.

Second, follow-up research should explore differences in need for support between different types of design tasks. Designing lesson series is a medium complex design tasks (Nieveen and Van der Hoeven 2011), which requires that teachers are able to design and align individual lessons in a well-considered order. For more complex design tasks, such as designing a complete new curriculum, support to foster teachers' design expertise might be different.

Third, although the results of this study suggest that supporting TDTs can enhance teachers' design expertise, additional research is required to determine the effect of support on teachers' ability of designing lesson series.

Finally, follow-up research should examine more closely how support is designed and offered in real-time during collaborative design processes, if and how the current guidelines are applied, and how support affects teachers' design expertise.

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