Developing a Learning Environment for Innovation Learning in Craft, Design and Technology Education

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Craft is a compulsory learning-by-doing subject for pupils in grades one to seven. The activities are based on craft expression, design and technology (CDT). This research is part of national endeavours to develop innovative CDT as a basic education subject. This paper briefly explores two studies in which technical work and textile work teachers taught together in a shared learning environment, rather than in traditionally separate learning environments divided into soft and hard materials. The aim is to develop criteria for a new kind of learning environment that promotes innovation learning in pedagogical innovation processes. A new kind of teaching culture that would advance pupils' innovation processes does not arise without deliberate new practice. The first study used a mixed methods approach, including systematic observation, inquiry and pair interviews of five co-teaching teams in primary school, to test the new teaching culture. The second study used an experience sampling method in the form of a mobile application to reveal various parts of pupils' design and making processes in the school setting. The present research offers two perspectives on how to advance pupils' innovation processes in a school context. Though this is action research, the results are consistent with earlier studies on school reforms and offers suggestions for how to face the CDT teaching tradition. Progress requires changes in both thinking and teaching culture—not only theoretically, but also in practice—to develop new ideas for how to renovate and construct learning environments that support pupils' innovation processes. The key finding is that collaborative teams can support teachers' and pupils' innovation learning activities when the work is supported by shared practices, spaces and new tools.

Key Words: Learning environment, Basic education, Co-teaching, School reform, Pedagogical innovation process.

1. INTRODUCTION

In Finland, craft teaching has a 150-year history in education for men and women and, later, for boys and girls. After the 1970s school reform, craft was divided into technical work and textile work in comprehensive schools. Since 1998, according to the Finnish Basic Education Act, crafts has been a single school subject. Thus, following a long and divided teaching tradition involving separate working spaces, teacher attitudes, ritualized routines and supporting myths, teaching has finally been reorganized into a co-teaching model. The change has been slow. In 2005 (Peltonen, 2007), the search began for new ways to educate teachers in a manner that would reduce the traditional division. In-service teachers still operate according to this traditional division.

As a school subject, craft is similar to design and technology education or technology education in many countries (Lepistö & Lindfors, 2015; Lindfors, 2015). In this paper, the concept of craft, design and technology education (CDT) is used as an English translation representing the tasks and objectives of Finnish craft education. Craft involves human- and practice-based experiential work with problems and challenges to create usable solutions. Design involves creativity and problem-solving based on values. Thus, design is part of a holistic craft (used in the Nordic context) or pedagogical innovation process. Technology involves understanding and using technology as a method, tool or technique to design, manufacture and fabricate innovative solutions on a student level, supporting technological literacy.

The present paper, which is part of an article-based dissertation, offers perspectives on creating new learning environments in CDT education based on two peer-reviewed pilot studies conducted in Finnish comprehensive education (Jaatinen & Lindfors, 2016; Jaatinen, Ketamo, & Lindfors, 2017). In the Finnish context, prior to 2014, two gender-based options for CDT existed. According to the National Core Curriculum (FNBE, 2014) and the Committee on the Alleviation of Segregation (FNAE, 2016), this approach is no longer permitted.

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However, in many schools, craft education is still divided into textile and technical work periods in two mentally and spatially separated learning environments. Pupils study a wide range of materials, but their different interests are not emphasized in contemporary ways. Prior research on what pupils choose to study when given a choice between textile work and technical work (with no other options) has shown that pupils tend to choose traditionally: girls choose textile work and boys choose technical work (Lepistö & Lindfors, 2015; Lindfors, 2012b).

In the present paper, we introduce the KÄSITÄKSÄÄ learning environment development project for CDT education (Jaatinen, 2017). Through two different studies, we examine two perspectives affecting the development of the learning environment: the teacher perspective, which shows how to create a new pedagogical approach based on co-teaching, and the pupil perspective, which shows how to develop teaching facilities and assessment methods. In an experimentation-driven approach, the information needed to realize critical phases does not yet exist and must be created by testing what works and what does not and learning from these experiences (Hassi & Tuulenmäki, 2012). An innovative idea in this research context is to first alter the pedagogical approach, thereby increasing the didactical possibilities supported by new spatial and instrumental resources, and to then make recommendations for developing learning environments based on observations of the studies. As Sawyer (2008) suggests, the basis of innovation is multidisciplinary collaboration.

2. THE THEORETICAL POINT OF DEPARTURE

2.1. Finnish school reform in basic education and the context school

The national core curriculum has been revised five times since the establishment of the comprehensive school in 1970. Finland has very few private schools, and learning outcomes do not vary significantly among schools. A common aim in CDT education is to make such education compulsory and shared for grades 1 through 7. However, a suitable solution for CDT education has not yet been found. According to recent research on attitudes towards CDT, pupils participating in education emphasizing technical work have distinctly more positive attitudes than pupils participating in education with equal amounts of technical and textile work. Pupils participating in education emphasizing technical work are also more likely to take part in an optional CDT course (grades 8 through 9) than pupils participating in education with equal amounts of traditional division (Hilmola & Autio, 2017).

Design and technology education can develop students' skills in a variety of equitable ways (Niiranen, 2018). For example, CDT education can be carried out according to the following models: 1) shared craft education, 2) from technology to design, 3) from idea to product and 4) innovation processes (Lindfors, Marjanen, & Jaatinen, 2016; Lindfors & Hilmola, 2016). In principle, gender is not a key issue when organizing teaching, and teaching is not based on sex; rather, we are actively building gender always (Lorber, 1994). Both boys and girls face various kinds of problems, and pupils must be understood as a heterogenic category (Lunabba, 2013). Equality is not about using 50% hard and 50% soft materials or providing everything to everybody through an equal division of production technologies. Instead, more alternatives must be tested.

Beginning in 2006, a wide range of technologies were implemented with equal amounts of technical and textile work in the project school. Co-teaching was launched in autumn of 2014 as a new solution for implementing the ideas of the new curriculum (FNBE). CDT was defined as a design process involving several techniques. This way of organizing CDT to emphasize pupils' varying interests and shared activities in a single learning environment has not previously been studied.

2.2. Learning environment and design process

The design of CDT learning environments has not yet been studied in Finland. Examples from Sweden show us that separate workshops have different classifications according to masculinity (Sigurdson, 2014). We are facing a major change toward teaching CDT in an equitable learning environment. In an altered learning environment, a CDT workspace consists of an individual workplace for each pupil, special workshops involving the use of various materials and technologies and a place for co-design and co-working. While working, pupils use the CDT workspace in a meaningful way by moving between their workplaces and the

workshops both independently and according to the teacher's guidance. This is done in the manner required by innovation learning and the phases of the pedagogical innovation process. The pedagogical innovation process is a creative and reflective problem-solving and design process for developing design thinking. It involves ideation, planning, making, and self-reflection conducted either individually or in a group. Learning environments offer pupils opportunities to design, manufacture and fabricate innovative solutions to meaningful problems or challenges; to assess holistic processes; and to develop highly usable solutions (Curedale, 2013; FNBE, 2014; Lepistö & Lindfors, 2015; Lindfors, 2012a; Lindfors & Hilmola, 2016; Lindfors et al., 2016).

In the project school, several aspects of the learning environment (Manninen et al., 2007, p. 15) were modified to support innovation learning (Figure 1). First, the space for learning was organized to enable co-teaching, and later, it was decorated as a lounge instead of a factory. Second, the pupils' workplace and different workstations and workshops were supported according to different phases of the flow. For example, what was previously the supervisor's booth was transformed into the pupils' secret corner or ideation place. Third, the practice was developed to be more design-oriented, focusing on transversal competence and co-teaching. Fourth, the community was widened spatially and virtually to support natural connections to other subjects. Finally, following Wilson's (1996, p. 3), changes were made to the learning environment resources, such as the QR code instrument used in the second study (Jaatinen et al., 2017).

Figure 1. Modified CDT learning environment

Earlier studies give us a broad perspective of good learning environments. Well-being in schools is based on school conditions, social relationships, means for self-fulfillment and health (Konu & Rimpelä, 2002). Learning environments should be safe and reflect connections to surrounding society (Piispanen, 2008). Good learning environments also depend on teachers' active collaboration in the design process (Nuikkinen, 2009). Successful teacher communities require supportive leadership, group dynamics and composition, as well as trust and respect for professional development (Vangrieken, Meredith, Packer, & Kyndt, 2017). Finally, learning environments should support possibilities to use modern teaching and learning processes (Kuuskorpi, 2014, 2012).

2.3. Co-teaching and new information technology resources

Craft learning environments play a key role in bridging the humanities and the sciences (de Melo-Martín, 2010; Snow, 1964). Traditionally, textile work is considered more human- and aesthetically oriented, while technical work is considered more technical (i.e. based more on natural sciences) (Kojonkoski-Rännäli, 2001, 2006). Recently, the co-operation between these two sciences has increased, and innovative campus complexes have been developed to bring together different experts. The project school's floor plan solutions focus on equality and individual needs (Nuikkinen, 2009; Sigurdson, 2014). Pupils need transversal competencies in their living environments that are both aesthetic and technical. The traditional system of allowing pupils to choose part of the content of their CDT led pupils toward unequal positions in both evaluation (Hilmola & Syrjäläinen, 2014) and technology learning (Lindfors, 2007). Co-teaching is a teaching experience for a heterogeneous group of students organized by two or more teachers, typically teaching in the same space, involving active teacher participation in planning, instructing and evaluating (Cook & Friend, 1995; Murawski & Lochner, 2011).

It is possible to design a new kind of CDT learning environment in the workspace using special workshops (Lindfors, 2010). Pupils' experimental production projects should be encouraged (Kallio, 2014). Earlier international studies have addressed the same questions, showing that it is possible to deconstruct technology's masculinity (Dakers, Dow, & McNamee, 2009) and that aesthetic awareness has creative value in design

education (Baynes & Baynes, 2010). An obstacle to development is the current lack of philosophical discussions of technological knowledge among CDT teachers (Hilmola, 2009; Norström, 2014). Teaching in technology has developed from isolation to co-operation (Männikkö-Barbutiu, 2011). Joint practice development is key to self-improvement (Hargreaves, 2014) and self-regulation is an important topic when defining learning tasks related to pupils' own technological and functional experiences (Metsärinne, Kallio, & Virta, 2015). In addition to social and physical considerations, information and communication technology is an important aspect of contemporary learning environments. Pupils' activities can be studied and supported in real time using mobile applications (Ketamo, 2009, 2011).

3. RESEARCH METHODOLOGY

Changes must be initiated and nurtured by real, identifiable people, including both individuals and groups (Engeström & Sannino, 2010). Teacher collaboration is key when experimenting with new ideas (Vangrieken, Dochy, Raes, & Kyndt, 2015) and attempting to implement a national core curriculum. To consider different perspectives on developing the learning environment, two studies were conducted. The research questions addressed in these studies were: I What is craft teaching when the approach is based on co-teaching instead of division? II How are pupils' activities and progressions seen at a curriculum level when using information collected by a self-assessment application in teacher-defined activities? The findings of this paper are based on two studies and represent possible means of enhancing practice (Figure 2). Thus I + II = How can teachers' and pupils' activities be supported in innovation learning?

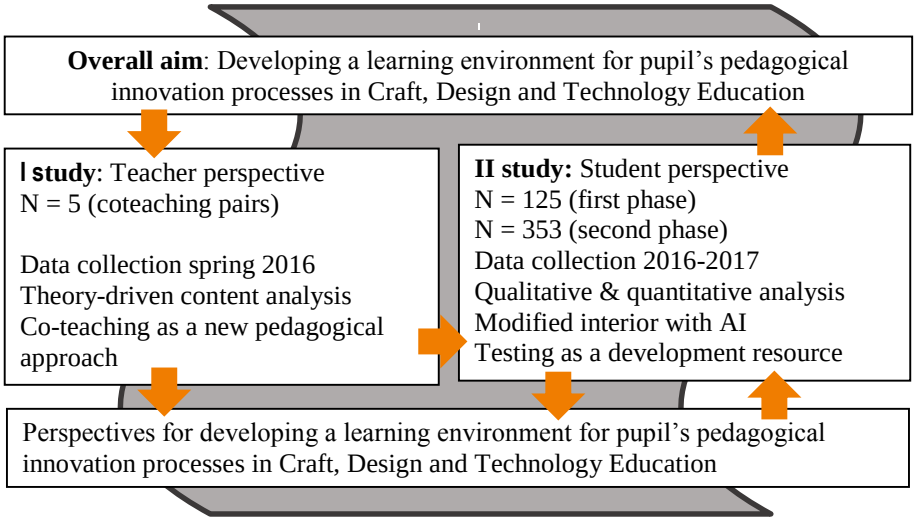

Figure 2. Research design

The first study used a mixed methods approach involving systematic observation, inquiry and pair interviews of five co-teaching teams in primary school. In the second study, an experience sampling method was used to examine a pilot implementation of a mobile application designed for use in classroom settings based on analyses of co-teaching. There was a need for a method to reveal pupils' activities supporting and not supporting pedagogical innovation processes. Using these methods, new scientific information was collected and used to develop principles for a future-oriented learning environment experiment.

4. RESULTS: STUDIES I AND II

Study I (Jaatinen & Lindfors, 2016) analysed co-teaching teams (two teachers, a classroom assistant and 18 to 21 pupils) in a learning environment that had been redesigned to promote pupils' pedagogical innovation processes. Qualitative data were drawn from systematic observations (22 hrs, 2 to 6 hrs/team), inquiries and pair interviews of five co-teaching teams in primary school grades 3 through 6 (Figure 3). Based on the theory-driven content analysis, the results of the study revealed that co-teaching was positively adopted as a new teaching approach. However, not all possibilities were utilized. For example, pupils' work should have been developed in a more collaborative direction. The initial findings suggest that proficiently performed co-teaching (Murawski & Lochner, 2011, 2014) opens new didactic opportunities to develop pupils' innovation processes.

The results are presented by describing 11 core CDT co-teaching competencies and ways to master both emerging and developing coteaching and proficient coteaching.

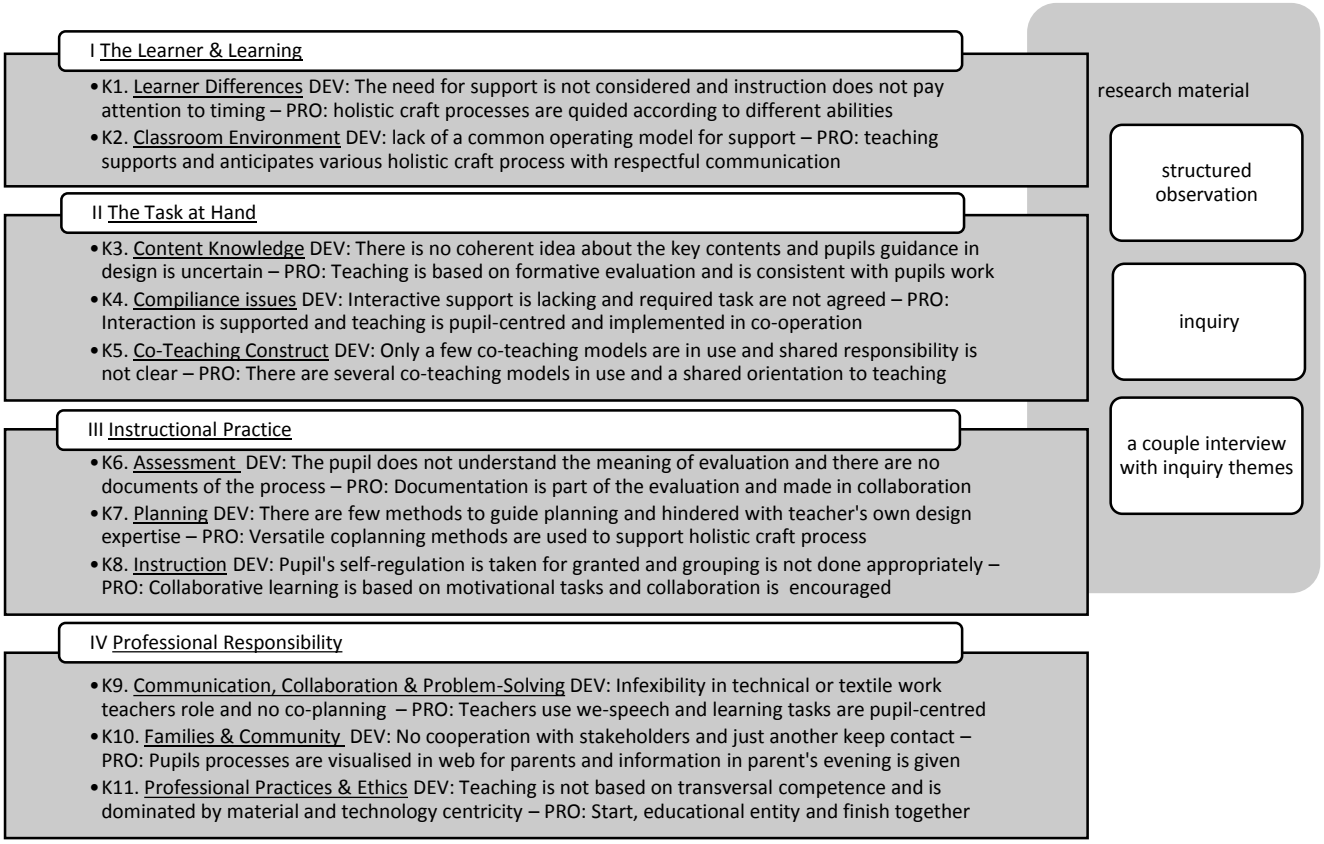

Figure 3. Researching and developing the core competences of CDT co-teaching: competences for K1 through K11. Created and adjusted based on the work of Murawski and Lochner (2011, 2014). Content based on the work of Jaatinen and Lindfors (2016). DEV = emerging and developing co-teaching; PRO = proficient coteaching.

Study II (Jaatinen et al., 2017) investigated pupils' processes in CDT education using an instrument for data collection and self-assessment. The school architecture and web-based learning environment were combined. The aims of the study were to: 1) make pupils' CDT processes visible in everyday classroom practices through information collected by a mobile application and 2) identify the curriculum topics covered during everyday classroom practices. The data were collected using an experience sampling method (Csikszentmihalyi, 2014; Hektner, Schmidt, & Csikszentmihalyi, 2007) with a gamified learning analytics instrument. The teachers' classroom activities served as the backbone for the thematic mapping of the curriculum (Figure 4). Preliminary measurements were carried out in grades 5 through 6 of a Finnish primary school (ages 10 through 12, n = 125) during a four-week period in 2016. The list of classroom activities was updated and tested in 2017 with all the pupils in the project school (N = 353). The key findings were: a) the self-assessment was easy for the pupils as a technical process, but there were several factors in the everyday classroom setting that made the process challenging, and b) it was relatively difficult for teachers to describe the classroom activities and process topics in terms of the curriculum. However, following the preliminary test, the teachers described activities in more detail and developed new activities that better supported the ideas of the curriculum.

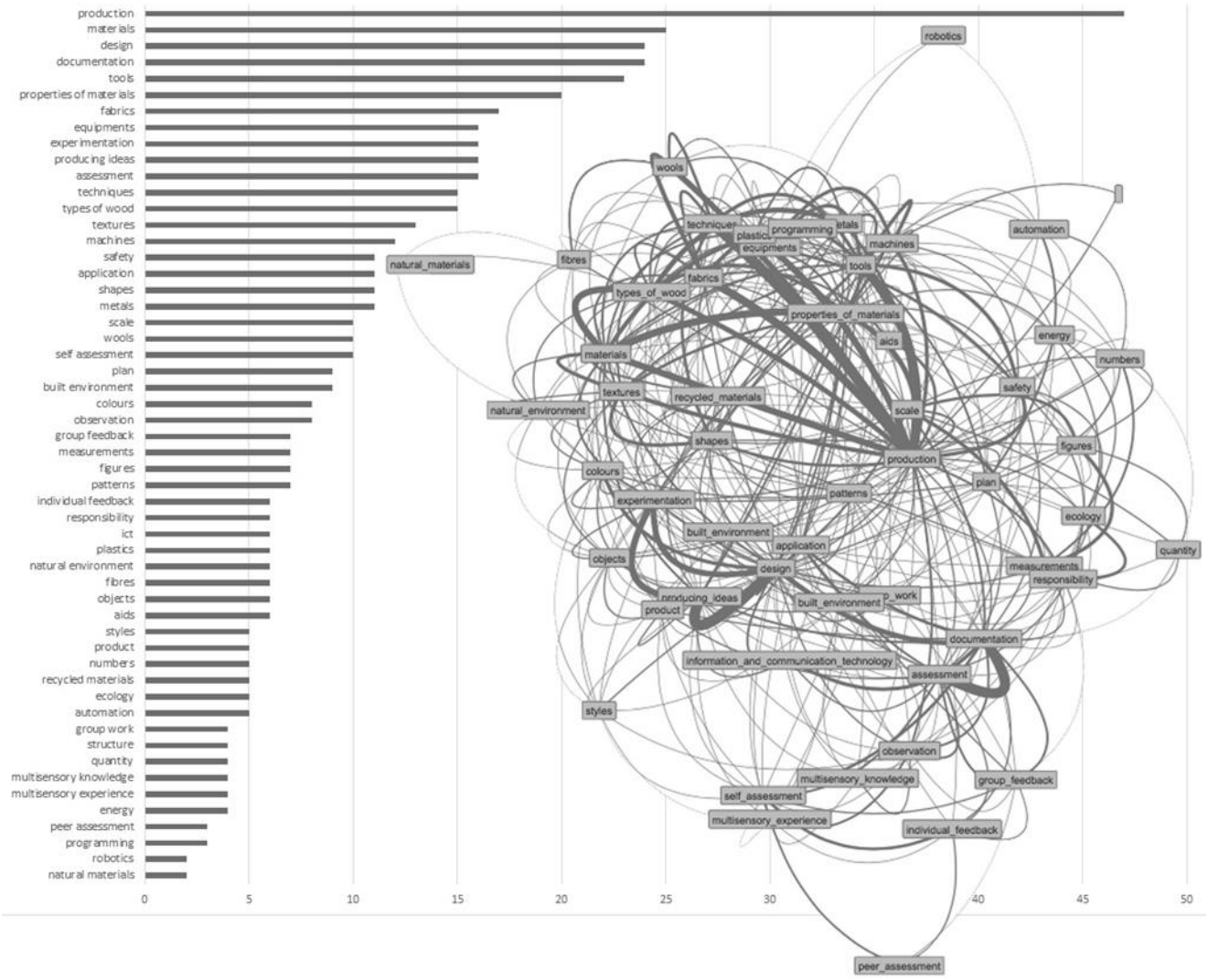

Figure 4. Left: the frequencies of the 54 curriculum keywords in the system. Right: a semantic network, built according to the keywords of the activities defined by teachers.

aken together, the results of the studies I and II facilitate a consideration of the CDT learning environment from different perspectives (Table 1). The results indicate that co-teaching teams can support teachers' and pupils' innovation learning activities when their work is supported by shared practices, spaces and new tools. Using the mobile application developed for the learning environment, teachers still initially defined craft as either soft or hard material production, but also improved their coverage of the content of the pedagogical innovation process. From the teacher perspective, it is important to support a shared vision of CDT and to use tools that face traditional approaches. From the pupil perspective, the key issue is not achieving equality across different materials but getting intensified support for self-regulation and individual needs in various processes. The learning environment should primarily be a space and a mental state for cultivating design and innovation, instead of mere production.

Table 1. Overview of the content analysis conducted in studies I and II.

Original publication	Study I	Study II
Data	Systematic observation, inquiry and pair interviews	Teacher-defined activity sets and detailed log data on pupils' processes
Method	Triangulation	Experience sampling method
Unit of analysis	Co-teaching core competence	Content objects and semantic networks of pedagogical innovation process
Focus of analysis	Teacher perspective: Possibilities of co-teaching	Pupil perspective: Pupils' holistic CDT processes in everyday classroom practices

Original publication	Study I	Study II
Intervention	New pedagogical approach	Piloting the ESM tool
Specific aims	Explore social and pedagogical factors in co-teaching	Explore mental and physical factors in pupils' processes
Results	Co-teaching is possible in CDT Competencies are mastered from emerging and developing to proficient coteaching and can be developed with pedagogical support	Pupils' activities are based on the options offered by teachers The piloted tool helped teachers better describe activities that supported the pedagogical innovation process
Answering overall research questions: Exploring different perspectives on change processes	Proficiently performed co-teaching opens new didactic opportunities to develop pedagogical innovation processes	Visualizations make pupils' different processes visible Classroom practices are not balanced in relation to objectives
Use of multiple materials	Learning tasks, co-teaching approaches	Pupils' different interests and shared activities
Innovativeness	New didactic opportunities	Help of new ICT tools
Equality	Intensified, gender-independent support according to pupils' needs	Key conceptual equality in CDT
Main contribution	Support for pupils' needs vs. teachers' needs	Better use of ICT can support the holistic craft process

5. DISCUSSION / CONCLUSIONS

Based on the results, it is a paradox that CDT teachers both oversee innovation learning and advance it through their work. In other words, CDT teachers are the owners of innovation learning in schools (Lindfors, 2012a).

Perspectives on developing a learning environment for pupils' pedagogical CDT innovation processes:

1) **The teacher perspective**: A good CDT learning environment consists of teachers' appropriate division of labour, as well as an environment and tools that support pedagogical innovation processes and pupils' self-assessment. One possibility is co- or team-teaching. Teaching design is challenging, even though teaching has always followed the objectives of CDT. In the teaching culture, everything affects everything. In this study, we focused on a single classroom; however, it is important to remember that technology education exists also outside of CDT.
2) **The pupil perspective**: For a CDT teacher, it is surprising that the only tool related to learning environment objectives described in the core curriculum (FNBE, 2014) is a mobile device. For pupils, it is an easy tool to use. Curriculum keywords might appear in different frequencies if design thinking and technological literacy are understood as main concepts of CDT. Timely support for pupils' needs is more important than the provision of multiple materials. It is important that pupils be able to choose the workshops and technologies most suitable for specific solutions. However, pupils need guidance in both design and the technologies used in production.
3) **The CDT**: The learning environment transcends the physical place of the classroom. The future-oriented CDT learning environment can be seen primarily as a "state of mind". It involves the re-evaluation of both teachers' and pupils' current practices. If workshops are not connected to the workspace in a way that makes them easily accessible to pupils, the old division in the curriculum will re-emerge.

The product- and gender-based traditions that have developed over the past 100 years are deeply entrenched. For some teachers and pupils, these traditions are so self-evident that they are difficult to question. Prior work has increased our understanding of innovation learning in CDT and revealed certain "truths" behind this concept. Though the present study presents action research conducted in the first author's school, the results are consistent with earlier research on school reforms. Attempts to change instructional practices take time and often fail (Hargreaves, Lieberman, Fullan, & Hopkins, 2009; Cuban, 1984; Fullan, 2011). This study offers suggestions for how to address the CDT teaching tradition. Earlier research on school reforms can be used, but

an optimal distribution system has not yet been developed. Teachers are not researchers, and reform should start from the bottom and move upward (Hargreaves, 2014). For this reason, new approaches are now being tested in real classroom settings with real teachers.

The old teaching system can be complemented or replaced, but we devote more attention to guiding in-service teachers in developing a manifold CDT learning environment. We must focus on the subject content and understand that innovation cannot be the work of a single person. In moving from the teachers' perspective towards the pupils' perspective, we see that the learning environment fosters learning in the surrounding society. With a little help from ICT and physical changes, a social learning environment can be developed. To accomplish such changes, however, teachers must work together. This is where CDT education is the most useful. Developing a new kind of CDT learning environment requires changing our thinking and considering the whole—not just theoretically, but also in practice—to find new ideas that will work. Ultimately, collectively held values make schools innovative.

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