Teachers' perceptions of social support in the co-planning of multidisciplinary technology education

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Abstract
In Finland, technology education is a multidisciplinary field where team teaching serves as a basis for the integration of technology across different school subjects. However, Finnish teacher education does not adequately prepare the student teachers for multidisciplinary technology education, and the professional competency is often gained through voluntary participation in professional development courses. The resulting individual differences in teachers' technology education competency hinder their ability to plan such educational offerings together. While previous studies have identified multidisciplinary team teaching as a way of balancing out individual differences in teachers' professional competency, the ability to leverage it depends on the availability of social support. Previous studies have examined the effect of social support in teachers' professional well-being, but further research on its role in organising multidisciplinary technology education is needed. This study explores what kind of social support is involved in the co-planning of multidisciplinary technology education. Eleven experienced in-service teachers representing different school subjects participated in interviews carried out in 2019–2020. The data were analysed by applying the principles of qualitative content analysis. The findings revealed that instrumental support in the form of new ideas, tools, and methods was emphasised in the teachers' experiences. The perceived needs for more social support were mainly related to making joint decisions during the co-planning process. The findings indicate that co-planning in multidisciplinary teams increases the versatility of possible implementations of technology education. However, leveraging multidisciplinary team teaching would require more support for pedagogical leadership.

Keywords
Team teaching, interdisciplinary approach, technology education, co-planning, social support, content analysis

Introduction
There is a growing body of evidence on how early exposure to multidisciplinary technology education motivates adolescents to pursue further studies in technological fields (Daugherty & Carter, 2018; Shalali et al., 2017; Ward et al., 2015; Yoon et al., 2014). As teachers in primary, secondary, and general upper secondary education have a central role in exposing their pupils to technology education across all school subjects, it is critical to understand how they can plan for joint offerings in multidisciplinary teams. Team teaching is a process where two or more teachers collaborate in planning, teaching and evaluation of a learning entity (e.g., Alsarawi, 2019; Pratt et al., 2017; Takala & Uusitalo-Malmivaara, 2012). In technology education, the planning stage often requires understanding of technology and its integration with other

disciplines (Bell, 2016; Jones & Moreland, 2004). Previous studies have revealed that teachers have individual differences in their expertise (El-Deghaidy & Mansour, 2015; Fahrman et al., 2019; Stein et al., 2001) and self-efficacy (Hartell et al., 2015; Nordlöf et al., 2019) related to technology education, which is prone to hinder their ability to engage and contribute in the co-planning process. While multidisciplinary team teaching has the potential to balance out these differences (Kafyulilo et al., 2016; see also Salonen & Savander-Ranne, 2015; Voogt et al., 2016), teachers' ability to leverage it depends on the availability of social support from colleagues (see Morelock et al., 2010; Scruggs et al., 2007). Previous research has identified the importance of social support in teachers' professional well-being (e.g., Greenglass et al., 1997; Kahn et al., 2006; Kinman et al., 2011; Russell et al., 1987; Schonfeld, 2001), but research on the role of social support in co-planning of multidisciplinary technology education is needed.

In Finland, technology education is a multidisciplinary and cross-curricular learning entity that is not bound into any single framework or school subject. The Finnish national core curriculum for basic education promotes technological understanding as a transversal competency, which should be integrated into the learning objectives of all school subjects (Finnish National Board of Education, 2014; Wang et al., 2019). Although teachers are allowed to organise their multidisciplinary teaching of technology freely (Härkki et al., 2020), Finnish teacher education does not adequately prepare student teachers for either technology education or team teaching. Consequently, the professional competency of multidisciplinary technology education is often based on in-service teachers' voluntary participation in professional development courses.

One of the possible ways for organising team teaching is a sequential approach, in which teachers of different school subjects take turns to introduce an independent, subject-specific and sometimes contradictory perspective to the topic at hand (Wenger & Hornyak, 1999). When organising team teaching as distinctions, each subject teacher introduces a complementary perspective to the common topic (Wenger & Hornyak, 1999). For example, a craft teacher may support pupils in working with prototyping materials, while a mathematics teacher advises them in computer programming. This way of organising team teaching may also be referred to as a simultaneous approach, in which two or more teachers combine their efforts to teach pupils in a shared space (Cook & Friend, 1995). For example, Finnish primary level class teachers are qualified to teach all school subjects, which lowers the threshold for collaborating with other teachers in a shared classroom. The most complex approach to team teaching is dialectic exchange, where teachers develop, evaluate, and synthesise different subject-specific ideas before introducing them to the pupils (Wenger & Hornyak, 1999). For instance, a team of subject teachers in music, arts, and biology can organise an open-ended learning process, where they approach technology by combining ideas from multiple subjects at once.

This study examined what kind of collegial support is involved in the co-planning of multidisciplinary technology education in Finnish primary, secondary, and general upper secondary level schools. To attend to this aim, the theory of social support (Cobb, 1976; House, 1981) was applied to identify teachers' experiences of emotional, instrumental, and informational support during the co-planning process. The following research questions were addressed:

1. What kind of social support do teachers receive in multidisciplinary technology education?
2. What kind of social support do teachers need in multidisciplinary technology education?

Theoretical Framework

Co-planning in multidisciplinary technology education

Technology education is still an emerging field; in most countries, it has been developed only over the past two or three decades (de Vries, 2009). It is often considered to have its roots in craft, vocational, and science education (de Vries, 2018). In the field of science, technology education has been situated in the framework of science, technology, engineering, and mathematics (STEM), which was introduced in basic and secondary education in the 1990s (Bybee, 2013; Land, 2013; Sanders, 2008). Recently, the STEM framework has been enriched with the 'A' representing arts, humanities, and design (Bequette & Bullitt Bequette, 2012), shifting the focus towards a more multidisciplinary and creative problem-solving process (Jones et al., 2013; Williams, 2012). The transition to the STEAM has been fueled by the need to educate future citizens, helping them become individuals who can understand, critically reflect, and creatively influence the technological world (Ge et al., 2015). In this approach, the teachers' role is to direct pupils through an open-ended problem-solving and design process, promoting both the aspects of knowledge-building and competency in using technology as a tool for creativity and innovation (Kangas et al., 2013; Riikonen et al., 2020). Organising experimental hands-on tasks enables pupils' collaborative knowledge creation (Yrjönsuuri et al., 2019). Despite recent developments, in many countries, technology education has less defined status in curricula than for example mathematics or science, and the understanding of its identity as a subject area is still evolving (Morrison-Love, 2017).

In Finland, technology education is a multidisciplinary and cross-curricular learning entity. Its organisation is based on team teaching where two or more teachers collaborate in planning, teaching and evaluation (e.g., Alsarawi, 2019; Pratt et al., 2017; Takala & Uusitalo-Malmivaara, 2012). Because co-planning forms the basis for the next phases of team teaching, it may be regarded as the most critical stage of technology education. In that stage, teachers often agree on the learning goals, share ideas on teaching and learning, explore each other's disciplinary perspectives, and negotiate between various possible teaching methods and practices suitable for implementation and assessment (Pratt et al., 2017; Udvari-Solner, 1996; Yinger, 1980). In the context of technology education, the planning stage often requires an understanding of technology and its integration with other disciplines (Bell, 2016; Jones & Moreland, 2004), which may be lacking from some individual teachers (El-Deghaidy & Mansour, 2015; Stein et al., 2001). Further, teachers may lack prior experience of facilitating open-ended problem-solving processes (Antink-Meyer & Meyer, 2016), which are integral to multidisciplinary technology education (Kangas et al., 2013; Riikonen et al., 2020). Even experienced teachers from different disciplinary backgrounds may have diverse expertise and ideas about the purpose and contents of technology education (Fahrman et al., 2019). Although multidisciplinary negotiation is challenging, it is crucial for constructing a shared framework for technology education (see Baker & Däumer, 2015; Rytivaara et al., 2019).

In addition to expertise in technology, teachers' actions in planning of technology education can be affected by self-efficacy, which refers to teachers' beliefs about their own expertise and ability to plan, teach, and evaluate activities for their pupils (see Bandura, 2012; Skaalvik &

Skaalvik, 2010). Self-efficacy is related to a self-perception of expertise that is different from teachers' actual expertise, but these beliefs influence teachers' decisions on how they apply their expertise (Tschannen-Moran et al., 1998). Teachers' self-efficacy in technology education comes from the sources of teacher education in technology, teachers' experience, and their own interest in technology education (Nordlöf et al., 2019). A previous Swedish study shows that teachers with subject-specific education in technology have higher self-efficacy than teachers without such training (Hartell et al., 2015). The continuous support for teachers is especially highlighted in a context, where technology education covers a broad subject area, because teachers can have a high self-efficacy in certain aspects of the domain and a low self-efficacy in some other areas (Nordlöf et al., 2019). While it is known that teachers' collaboration can strengthen their perceived self-efficacy, there is only a little qualitative understanding in how teachers perceive support from colleagues in planning (Chong & Kong, 2012).

Social support in the co-planning of multidisciplinary technology education

The ability to leverage the benefits of team teaching depends on support received from colleagues (Morelock et al., 2010; Scruggs et al., 2007), such as the degree to which individual teachers' disciplinary knowledge is available to others (Baker-Doyle & Yoon, 2011). Social support refers to the assistance received from others when dealing with the challenges of a certain environment (Thoits, 1986). The match between the support needed and support provided by others results in overcoming the challenges—but only if the support provided by others is perceived by the recipient (Haber et al., 2007). Thus, the actual support provided by the environment and perceived availability of the support should be examined as separate (Barrera, 1986). Based on the theories by Cobb (1976) and House (1981), Väisänen et al. (2016) distinguished three forms of social support: emotional, instrumental, and informational.

Emotional support refers to mental encouragement, and it provokes feelings of being trusted, respected, and valued (Cobb, 1976; House, 1981). In addition, emotional support may strengthen the individual experience of belonging to a certain network (Cobb, 1976), such as a group of technology educators. Emotional support has been considered the most important form of social support because of its stress-relieving functions (House, 1981). Accordingly, it has been suggested that the teacher community is a key factor in organising STEAM education because it enables teachers to share values and mutually commit to sharing goals and working together (Jho et al., 2016). Instrumental support refers to the practical assistance directed at managing a certain task (House, 1981; Mathieu et al., 2019). Based on Väisänen et al. (2016), instrumental support behaviours in teaching can be related to, for example, time, labour, or materials. In technology education, colleagues may support the planning of creative problem-solving activities. Sometimes, instrumental support functions can be embedded in other forms of social support if they together serve to solve a particular problem (House, 1981). For example, a teacher may need support in solving a technology-related problem in teaching. If colleagues provide emotional support by encouraging a teacher in problem-solving, emotional support can also be perceived to have an instrumental function. As defined by House (1981) and Väisänen et al. (2016), informational support includes two functions: information and appraisal. Informational support refers to receiving information that improves an individual's ability to cope with problems related to a certain environment (House, 1981). Väisänen et al. (2016) remark that often this kind of information is expected from an experienced person who has expertise in a particular area. For example, teachers can get information from their colleagues about the technological platforms that support them in planning technology education activities. In addition, informational support aids in appraisal, which means offering information relevant for self-evaluation (House, 1981). Feedback from others can be utilised for evaluating an individual (House, 1981), including their actions as a technology educator.

Previous research in education has applied the theory of social support mainly in relation to teachers' well-being. Perceived social support has been shown to decrease teachers' risk for emotional exhaustion and burnout (Greenglass et al., 1997; Kinman et al., 2011; Russell et al., 1987), contributing to improved professional efficacy (Kahn et al., 2006), job satisfaction, and motivation (Schonfeld, 2001). Perceived lack of social support has been connected to burnout (Brouwers et al., 2001; Burke et al., 1996; Cheuk & Wong, 1995), emotional exhaustion, and cynicism (Kahn et al., 2006). Although the forms of social support, and their contribution to teachers' well-being at work have been acknowledged, the body of knowledge on their benefits for co-planning of multidisciplinary technology education is limited.

Methods

Methodological approach

In this study, a qualitative research approach was chosen to create a comprehensive understanding of the social support involved in the teachers' experiences in the co-planning of multidisciplinary technology education. The study follows a constructivist research paradigm that includes a relativist assumption of reality as socially constructed and context-dependent (see, e.g., Mackenzie & Knipe, 2006). The results of this research are constructed from the meanings and interpretations that the teachers gave to their experiences in the specific interview situations. The results do not represent the general situation in Finland or cannot be applied in other contexts as such. However, the results provide insight into the unique experiences in co-planning of the in-service teachers who participated in this study.

Research context

Qualification as a teacher in Finland requires a completed master's degree, which requires five years of study in a university. Finland has a long tradition of research-based teacher education, which prepares teachers for being able to develop evidence-based practices for teaching and learning (Toom et al., 2010). However, the student teachers are not prepared for multidisciplinary technology education during their university studies, and there is no institutional professional education for in-service teachers in technology education. Technology education as an independent academic discipline was established in Finnish universities in 2018, as the first professors were recruited in the field. Before, the academic research in technology education had been integrated into the subject-specific pedagogical research of the STEAM fields. To enhance professional learning and development throughout the careers, the Finnish Ministry of Education and Culture promotes continuous learning programs as a part of the basic functions of universities.

This study is situated in the context of a technology education program piloted by two Finnish universities in 2019–2020. The program is targeted at student teachers and in-service teachers who are interested in technology education and who work at the primary, secondary, and general upper secondary levels. The aim is to encourage participants to inspire their pupils to learn about technology and develop the quality of technology education in their own work communities. The program applies the idea of multidisciplinary technology education, including three modules of five ETCS (European Credit and Accumulation System) each. During program participation, in-service teachers and student teachers organise team teaching experiments on multidisciplinary technology education in their own schools. Pedagogical and technological mentoring is offered to participants to support them with the experiments. The first module of the program introduces the participants to various innovative solutions for organising multidisciplinary technology education at different levels of education. The focus of the module is on supporting the co-planning of the participants' experiments. The module includes an introductory lecture about multidisciplinary technology education, teaching case examples, excursions, technology workshops, a reflection workshop, and a common 'shark tank' event, where the teams present their experimentation plans at the end of the module. For advancing reflection, the participants write learning logs by answering some supportive open-ended questions about their learning experiences. In the second module, attention is paid to the theme of team teaching in multidisciplinary technology education. The main theme of the third module is 'developer teachers' in the local school community.

Participants

The participants of this study were 11 in-service teachers from six teacher teams. The participants represented teams of two to seven teachers; most common team size was two teachers. The teachers were committed to the team teaching as a long-term collaboration. They co-planned teaching experimentations in multidisciplinary technology education, of which they were aiming to teach and evaluate together. The teachers worked at the primary, secondary, and general upper secondary levels in five different schools of 400—1000 pupils in Southern Finland. Three of the schools offered teaching at the primary and secondary levels, one school offered teaching only for the general upper secondary level, and one school had offering at all the levels of primary, secondary, and general upper secondary education. Two out of the six teacher teams planned technology education for primary school pupils, three teams planned teaching for secondary school pupils, and one teacher team had chosen general upper secondary school pupils as a target group. The teacher teams organised the co-planning in their own schools and the co-planning process was facilitated in the meetings of the technology education program.

The main criterion for selecting the participants was their background as experienced teachers. Most of them had previous experience both in technology education and working in multidisciplinary teacher teams. The length of the teachers' careers at the time of the data collection varied between six and 30 years. The teachers were qualified in a wide variety of school subjects, including mathematics, physics, chemistry, music, information and communications technology, and arts and crafts. Eight of the participants worked as subject teachers with one or more school subjects. Three participants were class teachers. In Finland, a class teacher can teach all primary-level subjects in their own class. One of the teachers had a leading role in the school community. The gender was close to an even distribution—there were five male and six female participants. The participants were given pseudonyms in the analysis.

Data collection

The qualitative research interview was applied as a data collection method for producing situated knowledge of teachers' experiences in co-planning (see, e.g., Qu & Dumay, 2011). The interview invitation was introduced in-person to all the 17 in-service teachers, who were attending the first module of the technology education program organised in fall 2019. Because the chosen research population of the in-service teachers in the technology education program was relatively small, more specific sampling criteria were not applied. Although all teachers expressed interest in participating in the study, six of them dropped out before the interviews. At the end of the module, the first author organised six in-depth group interviews with the 11 volunteering participants during 2019 and 2020. The first author was already familiar with the teachers and had an overall picture of the teaching experimentations that the teachers were planning, because she contributed in organising the technology education program. However, the first author did not participate in the co-planning activities that the teacher teams carried out. Before data collection, the participants were given explicit oral and written information about the research. Written consent for research participation was collected from the participants and no compensation was offered. The participants were aware that participation in the interviews did not affect the completion of the first module of the technology education program. They were informed of the possibility to cancel their participation at any stage of the study.

The semi-structured interviews focused on the teaching experimentation plans that the teachers had made in teams during the first module of the technology education program. The interview scheme (see Appendix 1) consisted of five sections. The sections were related to the context of co-planning, defining the experimentation idea, evaluation of the experimentation, external resources utilised during the co-planning, and further plans of how the teacher teams would like to continue with their experimentations. The interview scheme was tested in two pilot interviews before the actual data collection.

The interviewer gave the teacher teams freedom to choose the suitable time and place for their interviews to ensure easiness and convenience of the participation. Five teams were interviewed either in a quiet meeting room or in an empty classroom at their own workplaces. One teacher team chose a meeting room at the university as the place for their interview. The interviewer asked all the questions included in the interview scheme from the participants with an exception that a question was skipped if all the participants in the interview situation already clearly answered it. Occasionally, the interviewer asked additional open questions to encourage the participants to describe their experiences in a more detailed level, for example 'would you like to tell more about this' or 'could you give an example'. The interviewer paid special attention to the distribution of the statements, encouraging every participant to answer the questions. In two of the six interviews, the entire teacher team was not present. Especially in these interviews, the interviewer asked the participants to focus only on their own experiences, not on the perspective of their colleagues. The interviews were carried out in Finnish, each lasting from 50 to 110 minutes. The resulting 452 minutes of interview data were transcribed verbatim. The interview transcriptions were not possible to disclose in any public repository because of the confidentiality of the content.

Analysis

To create a condensed description of social support involved in the teachers' experiences in co-planning, the transcribed interviews were analysed following the principles of a qualitative content analysis (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004). The analysis was carried out in the three stages presented in Figure 1.

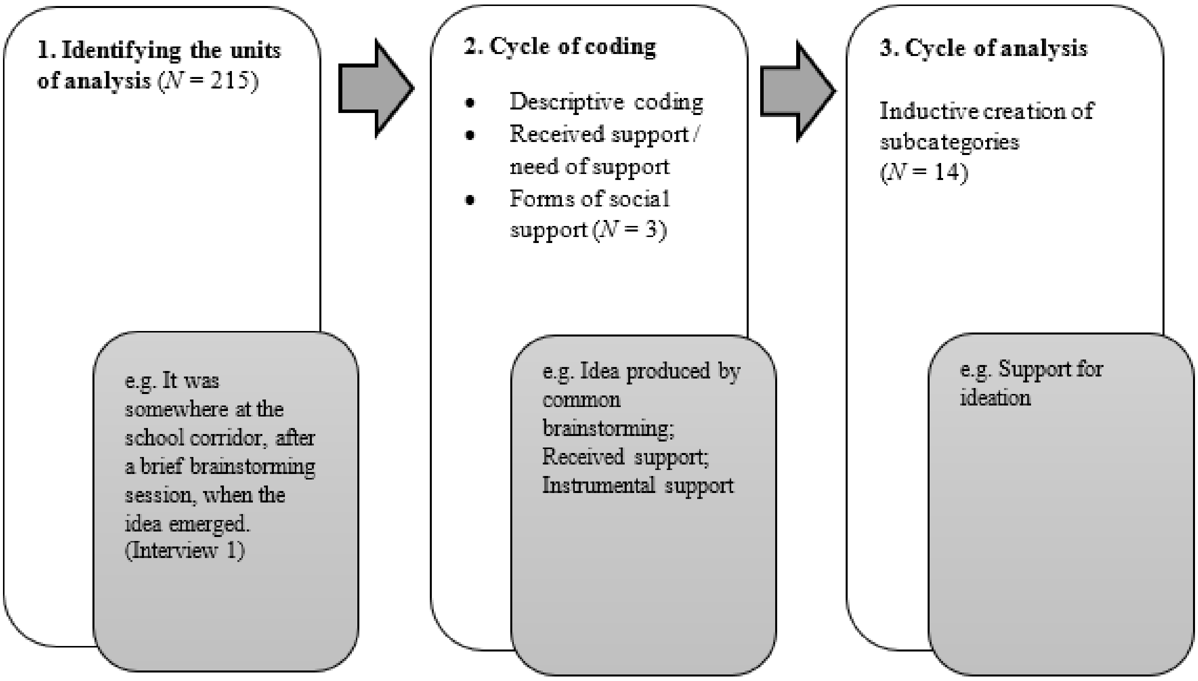

Figure 1. Analysis process.

The first stage of the analysis began by reading through the interview transcriptions several times to get an overall picture of their content. After familiarising with the data, the units of analysis were identified (N = 215). A unit of analysis was a coherent fragment of data that described social support or the need for it, here stemming from team teaching at the school environment. Each unit of analysis included statements from one or two teachers. Concerning the study aim, the focus of the analysis was decided to keep at the level of teacher teams instead of separating single teachers' responses from the interviews. Descriptions of the collaboration in the technology education program were excluded from the research in the phase of identifying the units of analysis.

The second stage of the analysis was a cycle of coding, where three simultaneous codes were assigned to each unit of analysis. First, a descriptive code for each unit of analysis was created by condensing its content briefly. Second, each unit of analysis was coded in terms of received support or need of support. As these two categories were not mutually exclusive, ten units of analysis belonged to both categories. Third, based on the theory of social support (Cobb, 1976; House, 1981) the units of analysis were coded into three main categories of emotional, instrumental, and informational support. The emotional support category contained mental resources, such as enthusiasm, encouragement, and sharing interests. The instrumental support category included the practicalities that directly supported teachers in their co-planning activities, such as shared ideation sessions, conversations, meetings, and sharing responsibilities over teaching. The informational support category covered information that supported teachers' actions as technology educators, such as the expertise and feedback offered by other teachers on technological or pedagogical aspects. Noting the overlapping nature of the different forms of social support (see House, 1981), there was a subtle overlap between the main categories created. Out of the total of 215 units of analysis, eight units were placed under two main categories, and one unit was related to all three main categories. To ensure the robustness of the first cycle of coding, the first and the second author coded one interview together by discussing their interpretations. Hereafter, the first author coded the rest of the data, and the second author worked as a second coder for three of the interviews.

The third stage included a cycle of analysis, in which the categorisation of social support was complemented with inductively created subcategories. At this stage, the units of analysis were clustered inductively based on their shared meanings by utilizing the descriptive codes already created at the previous stage. The first author carried out a tentative clustering, which was elaborated together with the second author. To raise the abstraction level of the analysis, the clusters were compared and grouped into preliminary subcategories. The authors continued categorisation until they both agreed that any new clusters and subcategories were not emerging from the data; this was deemed as a point of theoretical saturation of the analysis (see Corbin & Strauss, 2008). The resulting final coding scheme included three main categories and a total of 14 subcategories. Each main category included from three to seven subcategories, where each subcategory consisted from one to nine clusters of data. The 14 subcategories covered all 215 units of analysis of the data, and each of the subcategories represented data from two to six teacher teams. Most commonly, a subcategory consisted of the experiences of five teacher teams, average being 4.7 teacher teams per subcategory. Again, some overlap between the categories was found. Under the main category of instrumental support, five units of analysis were located under two subcategories. The main category of emotional support included two units of analysis located under two subcategories.

Results

Overview of the results

This study examined the social support involved in the co-planning of multidisciplinary technology education. The overview of social support involved in the teachers' experiences in co-planning is presented in Table 1. In the following subsections, the content of the categories is reported in a more detailed level from two perspectives: received support and needs for support.

Table 1. Social support in the co-planning of multidisciplinary technology education.

Forms of social support	Experiences in co-planning
Instrumental	Support for ideation
	Aid for the planning of teaching
	Flexibility in the guidance of pupils
	Cooperation in teaching
	More opportunities for implementation
	Pedagogical leadership
	Sharing responsibility for teaching
Informational	Technological expertise
	Pedagogical development expertise
	Knowledge of pupils
Emotional	Enthusiasm
	Encouragement
	Sharing interests
	Sense of community

Social support received in the co-planning of multidisciplinary technology education

The first research question concerned the social support received by the teachers in the co-planning of multidisciplinary technology education. In the teachers' experiences of receiving support, the emphasis was on instrumental support, which can aid a teacher team in their co-planning activities of multidisciplinary technology education. In addition to instrumental support, the teachers' experiences covered emotional support, which aids a teacher team in working for a common goal, and informational support, which includes information that supports teachers' actions as technology educators. The received social support in co-planning is presented in Table 2.

Table 2. Received social support in co-planning.

Forms of social support	Received support in co-planning
Instrumental	Support for ideation
	Aid for the planning of teaching
	Flexibility in the guidance of pupils
	More opportunities for implementation
	Cooperation in teaching
	Sharing responsibility for teaching
Emotional	Enthusiasm
	Encouragement
	Sharing interests
	Sense of community
Informational	Technological expertise
	Pedagogical development expertise
	Knowledge of pupils

Instrumental support

Most experiences of receiving instrumental support were related to *ideation*. Cooperation was considered as a way of improving the quality and increasing the number of potential ideas for teaching. Ideation was described as a shared effort in which every group member took part, usually by sharing their ideas in discussions. Cooperation made it easier to choose and define ideas for further development. In the following quotation, the importance of cooperation is highlighted in producing good ideas for the experiment:

> *When we made the plan together, as there were many of us present, the conversation started to find its course, and good ideas were produced in the joint discussion. (Interview 3)*

Cooperation worked as an *aid for the planning of teaching*, which consisted of support for overall implementation; choosing a target group of pupils, pedagogical approaches, and the theoretical framework for technology education, planning materials, and exercises; perceiving curriculum relations, utilisation of already existing contents and resources; choosing the applicable technology; planning the schedule; and planning excursions. The group discussions were viewed as a venue for sharing ideas about the concrete implementation of the experiment, as pointed out in the following quotation:

> *For a long time, we wondered what could be the first project to start with. It does not mean that this will be the only project and that we will continue with this forever. Actually, we have many visions that we could execute at some point. This one we considered as concrete and it was already implemented, so it will certainly succeed. (Interview 5)*

Working in a team was perceived to *add flexibility in the guidance of pupils*. Most of these experiences were related to sharing the guidance of pupils with others. Other teachers' and student teachers' presence in the classroom was seen as reducing a single teacher's workload by either co-teaching in the same classroom or dividing the groups of pupils into parts. In some experiences, flexibility in the guidance of pupils was also portrayed in terms of adaptive and dynamic guidance better meeting the pupils' needs. Cooperation enabled *more opportunities for implementation*. Opportunities to tie lessons of different subjects together made it possible to get in more time for technology education. There were also opportunities to widen the focus of the experiment by applying new tools and techniques and to get support for technology and building.

The presence of teachers from different areas of expertise was seen as a mean to promote *cooperation in teaching* between school subjects. Everyday encounters and previous experiences of working in common projects made the cooperation easier. The possibility of choosing a team based on each teacher's area of expertise was highlighted as important. *Sharing responsibility for teaching* lightened the teachers' workload. In a teacher team, every member had their own areas of responsibility.

Emotional support

In the experiences of receiving emotional support, *enthusiasm* typically emerged in the group conversations. Good feelings, positive expectations, and satisfaction with successful teamwork were shared during the co-planning process, as the following quotation demonstrates:

> *The ideas come from both of us and together we have […]. In a sense, it is nice that you cannot know whom the idea originally came from. One always inspires another. (Interview 5)*

Perceptions of *encouragement* were mainly related to the beginning of planning the experiment. The teachers were either encouraged to join the experiment by their colleagues and school community, or they encouraged their colleagues or student teachers to join their team. The following quotation points out how colleagues encouraged the teachers to join the experiment:

> *Well, my colleagues encouraged me to join [the experiment]. I was not under pressure; the information just was there. And then [a colleague] mentioned that this is a good thing, like, come along. And I started to think that okay, I could go, why not. (Interview 6)*

Sharing interests with other members of the team supported the teachers' work, especially in the phase of planning the experiment. Gathering around a common interest enabled well-functioning collaboration. As a form of social support, *sense of community* included experiences of fellowship because the teachers were in close collaboration or were friends outside of the workplace. Trust in colleagues and trust in the school community were experienced. Feelings of not being alone were seen as essential in the implementation of the experiment.

Informational support

In the experiences of receiving informational support, *technological expertise* was emphasised; this was related to both technological tools and platforms and the ways of applying them in teaching. For example, other teachers' and student teachers' knowledge of augmented reality, programming, and using a vinyl cutter were mentioned. Support for concrete building in implementing the project ideas was also recognised. The following quotation highlights the benefits of the teachers' combined technological expertise when it comes to enhancing pupils' learning:

> *It is the beauty and the difficulty of this kind of stuff that they [pupils] may come up with very new and surprising things that they would like to test, and I do not master all the techniques, and then I can think if [a colleague] could instruct, or if [another colleague] could instruct, and luckily there are several teachers involved. And, I consider it as very motivating for the pupils on that level to get actual freedom instead of always giving them the same task. (Interview 1)*

Pedagogical development expertise was related to implementing a multidisciplinary curriculum. The perceptions considered versatile subject didactical expertise because each teacher in a team brought knowledge of how the project ideas on technology education can be related to the teaching of their school subject. Working in a diverse team supported achieving a better understanding of a project as a whole. Sharing knowledge supported the formation of the boundaries for applying technology in the project, as described in the following quotation:

> *Of course, another [teacher] looks at [the experimentation plan] from their own perspective, whether it is realistic or not. I am sure that I have come up with such ideas that are impossible to build—according to the craft teacher. (Interview 5)*

Knowledge of pupils was formed by sharing practical experiences of teaching a target class. Conversations about pupils were seen as being overall supportive. In addition, knowledge that other teachers brought up in pupils' level of skills in their teaching subject supported flexible guidance in co-teaching situations.

Needs for social support in the co-planning of multidisciplinary technology education

The second research question concerned the social support needs of the teachers in the co-planning of multidisciplinary technology education. The social support needs in co-planning are presented in Table 3.

Table 3. Social support needs in co-planning.

Forms of social support	Needs in co-planning
Instrumental	Pedagogical leadership
	Cooperation in teaching
	Flexibility in the guidance of pupils
Informational	Pedagogical development expertise
	Technological expertise
Emotional	Sharing interests
	Encouragement

Pedagogical leadership was experienced as a major need of instrumental support by the teachers. These descriptions were related to joint decision-making during the co-planning process concerning timetables, group division, evaluation methods, the work division among teachers, aims of the experiment, and funding. In the following quotation, the need for a person leading the planning process is stressed:

> *I think that we should gather together with the whole team—we should agree on a person who is responsible for this and takes care of the meetings and that we do something. (Interview 5)*

The need for *cooperation in teaching* considered promoting multidisciplinary team teaching by inviting more colleagues from different backgrounds to join the experiment. *Flexibility in the guidance of pupils* was seen as essential because the planned activities often required more than one teacher to be successfully implemented.

The need for informational support included *pedagogical development expertise* and *technological expertise*. Pedagogical development expertise was needed for multidisciplinary curriculum implementation and the demand for renewing teaching. Implementing the new multidisciplinary curriculum was viewed as challenging, as described in the following quotation:

> *According to our curriculum, these multidisciplinary [topics] should be present in every school subject. Well, it is a bit problematic. - - We cannot try to push them all into the same project for getting all the multidisciplinary [objectives] to match. (Interview 6)*

The need for technological expertise was related to the technologies used during the implementation of the experiment. In one part of the perceptions, a specific need for expertise with a certain piece of technology was described, for example, in augmented reality–related technologies. In the other part of the perceptions, only a general need for expertise in technology was recognised.

The need for emotional support was rarely identified. The forms of emotional support that were called were *sharing interests* with colleagues who were truly willing to participate in the experiment and getting *encouragement* for experiments from principals and school district managers.

Discussion

Results in light of the previous literature

The aim of this study was to explore what kind of support is involved in one of the most critical stages of team teaching: co-planning. While previous studies have widely agreed on the benefits of multidisciplinary team teaching in balancing out teachers' individual differences in their professional competence of technology education (Kafyulilo et al., 2016; see also Salonen & Savander-Ranne, 2015; Voogt et al., 2016), the ability to leverage it depends on the availability of social support from colleagues (see Morelock et al., 2010; Scruggs et al., 2007). However, previous research on how teachers experience social support in multidisciplinary team teaching is lacking. This study sets the ground for leveraging social support in the context of multidisciplinary technology education.

The primary, secondary, and general upper secondary level teachers' experiences of co-planning of multidisciplinary technology education involved three forms of social support: instrumental, informational, and emotional support. In the teachers' experiences of social support, new ideas, tools, and methods for implementing technology education in a classroom were emphasised. This instrumental form of support involved in co-planning in multidisciplinary teams enriched the pool of possibilities for implementing technology education in the classroom beyond what an individual teacher could have come up with alone. As teachers may have limited, varying, and even conflicting views on the aims and methods of technology education (Kokko et al., 2020), negotiation on the joint focus on technology education is a prerequisite for successful multidisciplinary co-teaching (cf. Lehtonen et al., 2017). This study supplements previous research by highlighting the importance of multidisciplinary negotiations as an enabler for developing more versatile solutions for technology education.

Although teachers' instrumental social support provided new ideas for the implementation, they struggled to organise the decision-making processes without anyone having a formal leadership status over the others. Consequently, more support for organising and coordinating the co-planning process among teachers from different disciplines was called for. While previous studies have highlighted the importance of establishing common structures and routines for co-planning (Takala & Uusitalo-Malmivaara, 2012; Alsarawi, 2019; Pratt et al., 2017), the focus has often been on the role of formal school-level leadership in creating and maintaining a collaborative culture (Haapaniemi et al., 2020; Margot & Kettler, 2019). The findings of this study highlight the importance of informal team-level leadership as a critical form of instrumental support for the co-planning of technology education.

According to this study, teachers can leverage each other as a source of informational support related to technological expertise, such as selecting and applying suitable technological tools and platforms for the students. In addition to technological expertise, technology education requires expertise in integrating technological perspectives across disciplines (Bell, 2016; Jones & Moreland, 2004). Consequently, teachers called for more pedagogical development expertise to supplement the technological expertise of the multidisciplinary teaching team. Pedagogical support was especially needed in relation to fulfilling the multidisciplinary curricula requirements. Sharing pedagogical development expertise clarified the objectives and boundaries of the joint technology education offering; it also enabled the evaluation and testing of ideas from the perspective of different disciplines, which is referred to as 'appraisal' in the social support theory (House, 1981).

This study reveals that while multidisciplinary team teaching in the planning stage of a teaching process serves as a source of enthusiasm and encouragement, more emotional support was rarely called for during the co-planning process. Previous studies have identified the role of emotional support, such as sharing values and mutual commitment, as the most important resources for the implementation of STEAM education (Jho et al., 2016). Even though the teachers did not rely on each other for emotional support in the co-planning stage, the importance of emotional support is likely to be highlighted in the co-teaching stage. Such support is especially relevant when the degree of interaction with pupils increases and possible personal conflicts surface (see, e.g., Näring et al., 2012; Yin & Lee, 2012). In the meanwhile, the instrumental and informational forms of social support are highlighted as critical for balancing out teachers' individual differences in their professional competence of multidisciplinary technology education (see, e.g. Fahrman et al., 2019; Nordlöf et al., 2019).

Practical implications

As social support nurtures the co-planning of multidisciplinary technology education, in-service teachers should have more opportunities for collaboration in planning at the primary, secondary, and general upper secondary levels. For student teachers, teacher education should provide more opportunities to practice team teaching with their peers during training (see Weiss et al., 2015). In schools, formal pedagogical leadership should be applied to support the establishment of a collaborative culture among teachers (Haapaniemi et al., 2020; Margot & Kettler, 2019). In addition, informal pedagogical leadership is needed to ensure successful decision-making in co-planning. A possible solution could be developing ways to distribute leadership between teacher teams and the formal head of a school (see Blinkhorst et al., 2018; DeMatthews, 2014).

Limitations and further research ideas

The findings of this study reflect the views of a limited group of participants and are tied to the extent to which they recognise receiving and needing social support (see Haber et al., 2007). It is possible that the participants did not recognise all forms of social support involved in their co-planning efforts. It is also possible that they did not feel comfortable sharing the negative experiences of their team teaching in the group interview setting. Inductive method was applied in the analysis of the interview data. Although inductive reasoning gave the researchers purposeful direction for analysis, it should be noted that this approach draws on generalised conclusions. Because most of the participants had previous experience in co-planning of multidisciplinary technology education, the results may not apply to novice technology educators. In addition, the applicability of the results to tertiary-level education should be further explored.

The theoretical framework of this study provides a basis for further research on social support in team teaching in multidisciplinary technology education, including the phases of co-teaching and co-evaluation. Furthermore, the framework could be applied to a broader range of technology educators covering, for example, student teachers and tertiary-level teachers. Further studies are needed to explore the quality and applicability of multidisciplinary technology education plans resulting from the co-planning phase of team teaching.

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Appendix 1. Interview scheme

1. The context of co-planning

- Please describe your thoughts and feelings regarding the joint technology education planning process.
- Even though I am familiar with your teaching experimentation plan, please explain the following in your own words:
    - What the experiment will be?
    - Who will be included into the experimentation?
    - Are the student teachers involved in your teaching experiment? How so?
    - Where will the experimentation be implemented?
    - How will you carry out the experimentation (materials, equipment)?
    - Does technology have any role in your teaching experiment? What kind of role does it have?
- How did the planning process begin?
    - What kind of things did you discuss about when starting the planning process?
    - What kind of choices did you have to make in the beginning of the planning process?
- What kind of aspects influenced the planning process?
- What will the target group of your teaching experiment be?
    - Did the target group somehow have any impact on the planning process?
- Why did you participate in this teaching experiment?
- Because you as teachers represent different fields, did it somehow have an impact on the planning process?

2. Defining the experimentation idea

- How did you come up with an idea?
    - Why did you choose this idea?
    - Did you know straight away that you will choose this idea, or did you have some other options also?
- What are the pupils supposed to learn during the experiment?
    - What kind of learning aims are included?
    - Why did you choose these learning aims?
- As you had come up with an idea and defined the aims for your teaching experiment, how did you continue?

3. Evaluation

- How would you evaluate the ideas in practice?
- If you implemented the teaching experiment, how could you evaluate it?

- Do you see any constraints related to your plan?
    - *Refine, if needed*: Constraints mean something that especially needs to be considered when starting to implement the plan. For instance, the applicability of an idea for some specific school grades.

4. External resources

- What kind of information did you exploit during the planning process?
- Did you learn something new as you made the plan?
- If you implemented the plan now with this group of teachers, would you need to acquire some more expertise?
    - Where could you get the expertise needed?

5. Further plans

- Are you satisfied with your teaching experimentation plan? Why?
- Do you recognise any development points from your plan? What kind of?
- How could you further develop the plan?
- Would you like to complement your answers?