Education in the North

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Experiences of remote teaching, technological pedagogical competencies and workload of teachers in northern Finland during the COVID-19 pandemic

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DOI Number: https://doi.org/10.26203/p6gp-9729

To cite this article: Korte *et al.*, (2022). Experiences of remote teaching, technological pedagogical competencies and workload of teachers in northern Finland during the COVID-19 pandemic. *Education in the North*, **29**(2) pp.68-93.

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Abstract

In this study, we examine the experiences of teachers, particularly in relation to their remote teaching competencies, in the county of Lapland, North Finland, during the COVID-19 pandemic, as they face new pedagogical challenges in remote teaching. To identify the teachers' competency needs in remote teaching, the study uses questionnaire data (N=164) collected from primary, secondary and upper secondary school teachers. The results of the systematic representative survey study are analysed using the technological pedagogical content knowledge (TPACK) model to investigate the preconditions for and challenges in implementing remote teaching in terms of teachers' competencies. The participants' responses indicate that different municipalities prepared for remote teaching and learning in quite diverse ways. Some municipalities lacked the necessary tools for remote learning, and the workload increase and job satisfaction experienced by teachers were related to the digital tools provided by their employers. The development of teachers' diverse competencies is pivotal in teacher education and in-service teacher training so that they can acquire the ability to take initiative and function well in diverse and changing educational contexts. This study outlines the dimensions of teachers' technological pedagogical competencies that were further developed from the TPACK framework.

Keywords: remote teaching, basic education, upper secondary education, TPACK, teacher education

Introduction

Many educational institutions switched to remote teaching at short notice because of the outbreak of the COVID-19 pandemic in March 2020. Remote teaching takes place outside the traditional classroom setting. Time and geographic distance separate instructors from their students. Technologies, such as video conferencing programmes, message boards and learning management systems, are frequently used to support remote teaching (Chilton and McCracken, 2017). About 94% of learners worldwide, or 1.6 billion individuals, are suddenly faced with the challenge of remote learning (United Nations, 2020). In remote teaching, both teachers and students must adopt a new approach to ensure the continuation of schooling, which is learning for students and teaching for teachers. Previous research indicates that worldwide, teachers' remote teaching experiences during the pandemic have many similarities (Beardsley, Aragón and Hernández-Leo, 2021; König, Jäger-Biela and Glutsch, 2020; Perifanou, Economides and Tzafilkou, 2021). Making teaching entirely remote has challenged both students and teachers and, in some cases, has made it difficult to implement teaching. On the other hand, remote teaching has also had positive effects on the development of teacher competence and student learning. Our research complements the latest domestic research data (Ahtiainen et al., 2020; Tanskanen et al., 2021) by examining the remote teaching experiences of Lapland teachers, their self-assessed technological and technological pedagogical competencies and their need for support.

According to a national survey published in 2016 by the Trade Union of Education in Finland, teachers and school administrators have positive attitudes towards digitalisation. However, the digital leap has been implemented in the country in significantly different ways at different school levels over the last decade. Most teachers use information and communications technology (ICT) in administrative tasks and communication, and more than half of secondary school teachers use ICT actively. However, there are major gaps in teachers' pedagogical ICT skills, and active work is needed to integrate ICT into teaching, as in-service training has so far been insufficient and misdirected (Hietikko, Ilves and Salo, 2016). The country report by the European Commission in 2019 draws attention to the fact that the use of ICT in education in Finland is low, although learners in Finland enjoy the benefits of a high level of ICT infrastructure compared to the rest of Europe (see, e.g. the European Commission, 2019; Organisation for Economic Co-operation and Development, 2015; Tanhua-Piiroinen et al., 2016). In addition, Finnish students use their own mobile devices more often than their average European counterparts (European Commission, 2019).

According to the results of the Current State of Digitalisation of Learning Environments survey conducted by the University of Tampere's Research Centre for Information and Media (Tanhua-Piiroinen et al., 2016), half of Finnish teachers consider themselves basic users of ICT, and one in five teachers experience challenges in their technological competencies. Most teachers feel that they know how to use e-learning materials at least somewhat well, but almost half of them find the introduction of new technology to schools stressful to a certain extent. Overall, however, teachers are positive about the use of technology and are working to increase the application of technology to their teaching. Technology is often used as a highly teacher-led didactic means or tool (see, e.g. Ertmer and Ottenbreit-

Leftwich, 2013). According to research in Finland and elsewhere, teachers most often use ICT during lessons, whereas students use it relatively less (Körkkö, 2019; Tanhua-Piiroinen et al., *20*16).

The present study is based on a survey of the eLappi project, which examined the skills and experiences of Lapland teachers in digitalisation and was funded by the European Social Fund. Based on the survey results, in-service training for teachers was planned to provide tailored training that will support their technological pedagogical skills. The project was implemented in the county of Lapland, which includes 21 municipalities. Based on the national steering document, the curriculum (Opetushallitus, 2014) and steering education policies that guide municipal educational work in Finland, each municipality's national education policy is locally enacted independently, and teachers' pedagogical skills are supported differently (Laakso et al., 2022; Vitikka and Rissanen, 2019).

The remote teaching experiences of Lapland teachers and their self-assessed technological and technological pedagogical competencies were investigated through the following research questions:

1. What are teachers' remote teaching experiences in Lapland?
2. What kinds of technological pedagogical skills do teachers need when implementing remote teaching?

The answers to research question 1 are based on the questionnaires completed by the teachers, whereas the answers to research question 2 are obtained by analysing the results of the questionnaires against technological pedagogical content knowledge (TPACK) theory (Koehler and Mishra, 2009; Mishra and Koehler, 2006), which is explained in the following section. The TPACK model was chosen to showcase teachers' competency needs in a new pedagogical setting brought about by the COVID-19 pandemic. According to Jackson (1990), the abilities that a teacher needs to succeed are called competencies. In a particularly complicated setting, where hundreds of vital decisions must be made every day, teachers need to be highly skilled in order to enhance student learning (Jackson, 1990).

The geographical area covered in this study was wide reaching—the entire Finnish Lapland county (Figure 1). Hence, the results of the study provide information on teachers' remote teaching experiences, competencies and support needs. The results can be used to further develop pre-service teacher education and in-service teacher training.

Finnish primary education is preceded by one year of compulsory pre-primary education, followed by nine years of basic education (comprehensive school) and upper secondary education, which consists of general and vocational education (Finnish National Agency for Education and Ministry of Education and Culture, n.d.). In Finnish primary school teacher education programmes, students can choose minor subjects according to their personal interests. Basic and subject studies from one minor subject together with multidisciplinary studies in primary school subjects (60 ECTS) and pedagogical studies (60 ECTS), provide students with qualifications to teach that particular subject at the secondary and upper secondary levels. According to Teaching Qualifications Decree 986/1998, §4 (Asetus opetustoimen henkilöstön kelpoisuusvaatimuksista 14.12.1998/986), the primary school teacher education programme qualifies students to work with classes 1–6 at the primary school level. Training of subject teachers is organised separately (Kosunen and Mikkola, 2002).

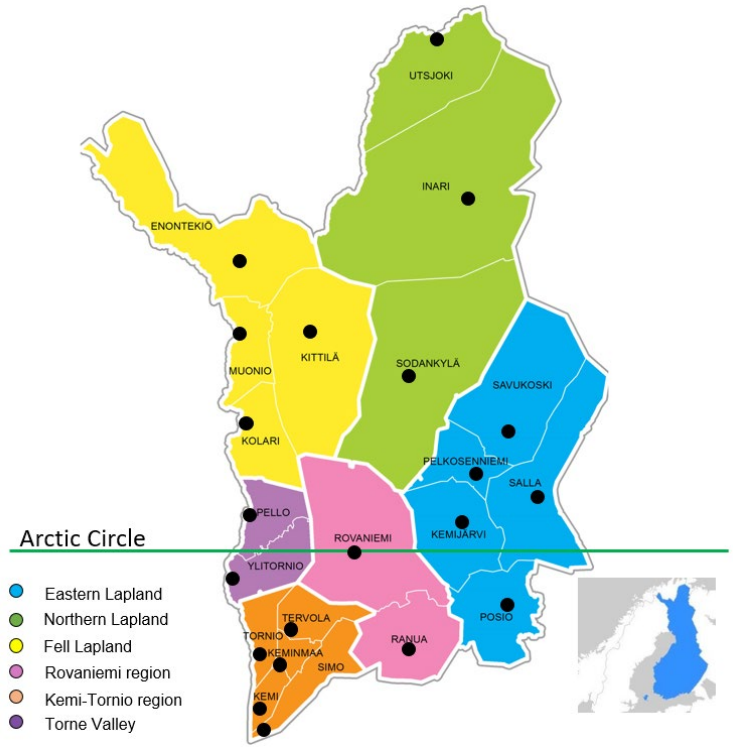

Figure 1: map of Finnish Lapland regions and the included municipalities with their administrative centres (modified from Lapin liitto n.d.)

Theoretical framework

This study uses the TPACK model, which aims to combine related content knowledge, pedagogy and technology, as its theoretical grounding (Koehler and Mishra, 2009; Mishra and Koehler, 2006). The TPACK model has been widely used in research on teachers' digital competencies. However, recent research has identified some limitations of TPACK, particularly its lack of technology-related ethical and attitudinal dimensions (McDonagh, Camilleri, Engen and McGarr, 2021). In this study, the model was applied in the assessment of teachers' technological pedagogical competencies, as it is well suited for the study of professional competence and its development (Abell, 2008; Kyllönen, 2020) and for the design of targeted solutions.

The TPACK model has been used nationally and internationally, especially in research and development related to the technological pedagogical competencies of teacher students, as well as in research on the competence and competence development of teachers already in employment. This work complements Finnish TPACK studies, as some of these have focused on the model itself and its testing and definition (Chai, Koh and Tsai, 2016; Sointu et al., 2016), as well as on measuring TPACK competence (Lee and Tsai, 2010). Some studies have highlighted interventions aimed at developing teacher competence (Kyllönen, 2020; Voogt, Fisser, Pareja Roblin, Tondeur and Van Braak, 2013). Research has also been conducted on contextual factors related to the TPACK model (Kelly, 2007).

The model indicates that the effective integration of technology into teaching requires teachers to master the related content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). They also need information from the interfaces between these—technological content knowledge

(TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK) and technological pedagogical content information—which together form TPACK (Mishra and Koehler, 2006). CK is information about the content of the topic being taught and the extent to which it is covered. Content information defines the competencies expected of a teacher. PK includes knowledge and experience of teaching and learning processes. PCK refers to the information related to the subject being taught, pedagogical knowledge of teaching the subject and the methods best suited to teach the subject. TK is the ability to use technological tools and apply them to achieve teaching goals. TCK refers to the use of technological devices, programmes and applications in teaching. TPK comprises knowledge of the opportunities that technology offers for teaching and learning and the limitations it brings. All the above types of knowledge are combined in the TPACK framework (Koehler and Mishra, 2009; Mishra and Koehler, 2006), which is the basis of technology-based teaching.

Methods

Collection and analysis of the research material

The research material was collected using the Webropol online survey tool in Finnish, the aim of which was to map the experiences of teachers in the Lapland region, North Finland, regarding remote education during the COVID-19 pandemic; the teachers' self-assessed technological and technological pedagogical competencies and their need for support related to remote education were also analysed. The questionnaire was developed based on the TPACK model (Koehler and Mishra, 2009; Mishra and Koehler, 2006), so its questions represent technological and technological pedagogical aspects of the model and those that are significant for this study (Appendix 1). The survey contains a total of 18 questions, including selection, matrix and open-ended questions. The questionnaires were sent to the 21 directors of education in the municipalities of Lapland, who were asked to forward the questionnaires to primary school teachers. The first round of data collection was conducted between 20 May and 5 June 2020. The responses to the survey were completed in the second data collection round from 18 August to 18 September 2020 because the first attempt was done right before the schools closing for summer holidays. Hence, the questionnaires were sent again immediately after the holidays to collect more responses. A total of 167 people responded to the survey, three of whom declined to let their responses be used for research purposes. Thus, data from 164 respondents were used for the research. In 2019, 945 teachers worked at the primary or secondary school levels or at the upper secondary level in Finnish Lapland (Finnish National Agency for Education, 2019a; 2019b). Hence, the survey response rate was 18%. A privacy notification and information about the research were included in the survey. The teachers gave their consent for the research before answering the survey. The data were collected and analysed anonymously so that individual responses could not be traced back to specific participants.

Open-ended questions were chosen based on the findings of previous studies on the essential elements of job satisfaction. For instance, Otala and Ahonen (2005) found that the available working tools are factors that contribute to job success and satisfaction. The first open-ended survey question addressed the issue of transition to remote teaching. The second question focused on the evaluation of students' learning. The third question asked about the need for support in the execution of remote

teaching. The fourth question addressed the positive aspects of remote teaching and the fifth question focused on problems with remote teaching. The sixth question focused on utilising remote teaching in the future.

The qualitative data were analysed using thematic analysis (Mayring, 2014). Responses to each open-ended question were analysed separately by the second author by reading through the responses and examining similarities and differences. Based on this initial coding, the responses were divided into themes according to their content. The final themes were discussed and deliberated upon by all the authors. The questions are presented in Appendix 1, themes and their frequencies are presented in Appendix 2.

The first closed question focused on receiving support during the transition to remote teaching. The following question was about the technical tools that the teachers used when teaching, and this was followed by a question that addressed the planning of remote teaching. Then the teachers were asked about their possibilities of considering pupils' special needs and then about their perceived stress. Next the teachers evaluated their success in remote teaching which was followed by questions focusing on the teachers' technological competencies and technological pedagogical competencies. The teachers evaluated their competencies using a five-point Likert scale. The final four questions were demographic questions, which asked for their names, years of work experience, municipality of workplace and education. The teachers were also asked about the support material and supplementary education they wanted to receive through the project.

The quantitative data were interpreted using IBM SPSS Statistics. The relationships between the different variables in the data were examined using cross-tabulation, correlation coefficients and correlation matrices, and the statistical significance of the means between the groups was analysed using one-way ANOVA. Factor and regression analyses were applied as multivariate methods in the analysis. Finally, both the data and the results were examined using the TPACK model (Koehler and Mishra, 2009; Mishra and Koehler, 2006), where applicable.

Most of the respondents worked in Tornio (29%) and Sodankylä (14%), whereas teachers from the largest cities in Lapland were under-represented (Rovaniemi: 4%, Kemi: 7% and Kemijärvi: 7%) (Figure 1). No more than 5% of the respondents represented all other municipalities. The exception for small municipalities was Inari, which represented 7% of the respondents. The participants were representative of different age groups. The most common age group was 51–60 years old (40%). The respondents included both early-stage and experienced teachers, with 31% having between 21 and 30 years' experience and 29% having a maximum of 10 years' experience. Most of the respondents were subject teachers in basic education (54%) and classroom teachers in primary education (43%).

Findings

In this section the findings of the study are presented. First, teachers' remote teaching experiences in Lapland are discussed, which is followed by the examination of their self-assessed technological and technological pedagogical competencies in light of the TPACK (Koehler and Mishra, 2009; Mishra and Koehler, 2006) theoretical framework.

What are teachers' remote teaching experiences in Lapland?

In the transition to remote teaching, teachers would have wanted to receive more training, support and guidance regarding the use of different applications. The second most popular response was the need for common policies on remote teaching and more time for the transition. During this period, support most often came from colleagues (87%) or supervisors (49%), and it was also received in the form of technical support from the municipality, the school itself or social media (43% each), whereas 5% of the respondents did not receive support. For other sources of support, friends, family and neighbours were mentioned. When asked about remote teaching planning, the majority of the respondents stated that they mostly planned their teaching during the COVID-19 pandemic independently (93%). In addition, 18% of the respondents reported mostly planning their teaching in collaboration with another teacher. Only 1% of the respondents indicated that they planned their teaching in some other way. The most commonly used tools were computers (personal or employers) and Google forms for students' learning evaluations and tests.

In the implementation phase of remote teaching, teachers would have wanted to receive more general training, support and guidance. The second most popular requirement was cooperation with colleagues, including joint planning. According to the teachers, the problems encountered in the implementation of remote teaching were related to technical issues and difficulties in reaching and communicating with students, as well as omissions and absences. Other problems were related to the students' use of differing remote learning tools and weak ICT skills, as well as to supporting and differentiating students' learning, motivation and self-control.

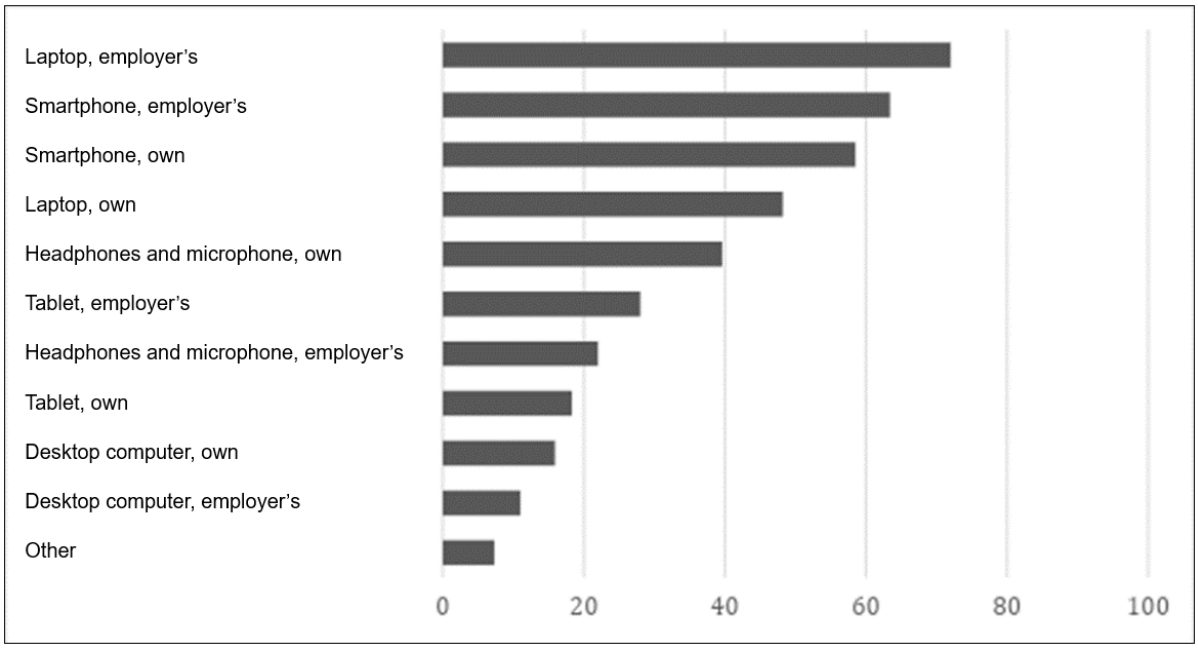

Figure 2: remote teaching solutions used (relative proportions of individual choices among all the respondents)

According to the teachers, a positive aspect of remote teaching was that some students benefited from it, as their learning outcomes improved. The reasons for this were the students' ability to control their own progress pace, and to concentrate better at home and experience peace of mind during their

studies, as well as the removal of social pressure. The development of the students' and teachers' ICT skills and the facilitation of individualisation and differentiation in teaching, as well as the development of students' self-control, were also identified as positive elements. Therefore, remote teaching had positive effects on both the IT skills of teachers and students and the learning outcomes of some students. Concerning the utilisation of remote teaching in the future, most respondents mentioned thoughts about using different solutions (applied during remote teaching) in classroom teaching.

The most common remote teaching tools for the teachers who responded to the survey were their own or their employers' laptops and smartphones (Figure 2). The least used were their own or their employers' desktop computers.

According to the teachers, the use of digital tools provided by their employers was statistically significantly associated with an increase in their experience of work success, whereas the use of one's own digital tools was statistically significantly related to an increase in one's workload. The experiences of success and an increased workload were included in the survey through the following questions: To what extent did you succeed in implementing remote teaching? and To what extent did your workload increase with remote teaching?" The majority of the respondents (77%) felt that they succeeded in implementing remote teaching very well. Similarly, the majority (72%) felt that their workload increased with remote teaching. The answer options for success in the remote teaching variable were classified for in-depth analysis as follows: 0 = not at all, very little or to some extent; 1 = much or very much (well or very well). The classification of the explanatory variables (remote teaching tools) was as follows: 0 = was not used to organise remote teaching; 1 = was used to organise remote teaching.

From the data on the connection between individual remote teaching tools and the experience of success in remote teaching, a link can be observed between the provision of both smartphones and tablets by employers and an increase in the success experienced in remote teaching (Table 1). About 12% of the teachers who used employer-provided smartphones felt that they were very successful in implementing remote teaching compared with those who did not use employer-provided smartphones. An even greater difference was observed between those who did and did not use tablets provided by their employers. About 20% of the teachers who used employer-administered tablets felt that they had achieved much success in their remote teaching compared with those who did not use employer-administered tablets. By contrast, using one's own or employers' desktop computers was found to be associated with a diminished experience of success in remote teaching. Of the teachers who used their own or their employers' desktop computers for remote teaching, about 6% and 12% fewer, respectively, succeeded in implementing remote teaching well or very well compared with the teachers who did not use these remote teaching tools.

From the data on the teachers' remote teaching experiences, it can be seen that their workload increased substantially (average $\bar{x}$ = 4.0) on a scale of 1–5 (1 = not at all; 5 = very much), but at the same time, their teaching was successful ($\bar{x}$ = 4.0), even if it was possible to consider the needs of students with special needs only to some extent ($\bar{x}$ = 3.3). Workload (Table 2) was inversely examined in relation to the experience of success; at most, the experience of some teachers who had an increase

in workload was interpreted as a benefit of remote teaching if higher relative response rates were observed in this category compared with the case of non-users of remote teaching tools (i.e. to what extent did your workload increase with remote teaching? 0 = much or very much; 1 = not at all, very little or somewhat).

Table 1: connection between the use of remote teaching tools and the experience of success in remote teaching

Remote Teaching Tool	**Experience of Success**	**Use of Remote Teaching Tool**			
		No		Yes	
		%	n	%	n
Laptop, own (p = NS)	To some extent at most	24	20	22	17
	Much or very much	76	64	79	62
	Total	100	84	100	79
Laptop, employer's (p = NS)	To some extent at most	24	11	22	26
	Much or very much	76	35	78	91
	Total	100	46	100	117
Desktop, own (p = NS)	To some extent at most	22	30	28	7
	Much or very much	78	108	72	18
	Total	100	138	100	25
Desktop, employer's (p = NS)	To some extent at most	21	31	33	6
	Much or very much	79	114	67	12
	Total	100	145	100	18
Headphones and microphone, own (p = NS)	To some extent at most	24	23	22	14
	Much or very much	77	75	79	51
	Total	100	98	100	65
Headphones and microphone, employer's (p = NS)	To some extent at most	24	30	19	7
	Much or very much	76	97	81	29
	Total	100	127	100	36
Smartphone, own (p = NS)	To some extent at most	24	16	22	21
	Much or very much	77	52	78	74
	Total	100	68	100	95
Smartphone, employer's (p = NS, 0.082)	To some extent at most	31	18	18	19
	Much or very much	70	41	82	85
	Total	100	59	100	104
Tablet, own (p = NS)	To some extent at most	22	29	27	8
	Much or very much	78	104	73	22
	Total	100	133	100	30
Tablet, employer's (p = 0.007)**	To some extent at most	28	33	9	4
	Much or very much	72	84	91	42
	Total	100	117	100	46

Table 2: relationship between the use of remote teaching tools and the perceived increase in workload

Remote Teaching Tool	**Perceived Increase in Workload**	**Use of Remote Teaching Tool**			
		Yes		No	
		%	n	%	n
Laptop, own (p = NS)	Much or very much	68	56	77	61
	To some extent at most	33	27	23	18
	Total	100	83	100	79
Laptop, employer's (p = NS, 0.080)	Much or very much	83	38	68	79
	To some extent at most	17	8	32	37
	Total	100	46	100	116
Desktop, own (p = 0.003)**	Much or very much	68	93	96	24
	To some extent at most	32	44	4	1
	Total	100	137	100	25
Desktop, employer's (p = 0.047)*	Much or very much	75	108	50	9
	To some extent at most	25	36	50	9
	Total	100	144	100	18
Headphones and microphone, own (p = NS)	Much or very much	68	66	79	51
	To some extent at most	32	31	22	14
	Total	100	97	100	65
Headphones and microphone, employer's (p = NS)	Much or very much	75	94	64	23
	To some extent at most	25	32	36	13
	Total	100	126	100	36
Smartphone, own (p = NS)	Much or very much	69	47	75	70
	To some extent at most	31	21	26	24
	Total	100	68	100	94
Smartphone, employer's (p = NS)	Much or very much	79	46	68	71
	To some extent at most	21	12	32	33
	Total	100	58	100	104
Tablet, own (p = NS)	Much or very much	71	94	77	23
	To some extent at most	29	38	23	7
	Total	100	132	100	30
Tablet, employer's (p = NS)	Much or very much	75	88	64	29
	To some extent at most	25	29	36	16
	Total	100	117	100	45

The perceived increase in workload substantially varied between those who experienced an increase to some extent and those who mostly used (15%) an employer's laptop (25%), an employer's headphones and microphone (11%) and an employer's smartphone (11%) or tablet (11%), when the

use of any of their own technical aids was not associated with a reduction in the increase in workload. On the other hand, the use of one's own desktop computer was related to a perceived increase in workload (28%). Based on the results, it can be concluded that the technical aids provided by an employer had significant effects in reducing the increase in workload of the teachers during the COVID-19 pandemic. However, only the observations concerning the use of an employer's desktop computer or one's own desktop computer were statistically significant.

Because individual dependency studies provide information only about the association between individual remote teaching tools and experiences of success or workload, such a relationship was further examined using logistic regression analysis. In this way, the association was investigated independently of other explanatory factors (remote teaching tools). In the logistic regression model, when the draw ratio (Exp(B)) is greater than the integer, the risk of belonging to the group under consideration is greater than the risk of belonging to the control group; on the other hand, if the draw ratio is lower than one, the situation is the opposite (Rita, Töttö and Alastalo, 2008). With the classifications of the variables used in this article, draw ratio values that are higher than one mean an increase in the experience of success and a decrease in the workload in the analyses of experience of success and workload, respectively.

In the first logistic regression model with all the explanatory variables, only the *tablet employer* variable statistically significantly ($p = 0.017$) explained the experience of success in organising remote teaching. Subsequently, all the statistically non-significant explanatory variables were removed from the model, except for *desktop employer*, with a p-value of 0.10, which comes quite close to the most commonly applied maximum rejection limit of 0.05 for the null hypothesis. Recalling the contractual nature of the statistical significance limits (with a p-value of 0.1, the null hypothesis is rejected in 90% of all the other random samples of the same size), the desktop employer variable was still included in the model at this stage. Age was then added to the model as an explanatory variable, as the potential increase in the experience of success with remote teaching technical tools may also be related to the age of those using them, with ageing possibly increasing cognitive difficulties. Studies show that certain cognitive abilities, such as spatial perceptual ability and speed of perception, remain fairly intact until the age of 45, after which they deteriorate more rapidly (Singh-Manoux et al., 2012). For this reason, when examining the relationship between the use of different technical tools and the experience of success in implementing remote teaching, researchers need to use age as a control variable in the model. In this way, the impact of technical aids on the experience of success can be determined regardless of the age of the person using them. In addition, as it is presumed that interactions exist between different technical tools and age in relation to the experience of success, the interactions between age and the technical aid variables included in the model at that stage were also added to the model in the final step. This was not carried out in the early stages of modelling, as the model would have become far too complex if, in addition to all 10 aid variables, their separate interactions with age were modelled simultaneously with the main effects. Age was reclassified as a bivalent dummy variable (0 = up to 45 years of age; 1 = over 45 years of age) based on the above observations of the age of 45 as a refractive point for cognitive impairment.

The results show that an employer's tablet (traction ratio = 4.3), which was linked to a statistically significant increase in the experience of success in the first model, remained a statistically significant explanatory factor in the last model (no.4), from which the non-significant interactions had been removed (such as the main effect of the age variable and the interactions between age and the most important tool variables). In the final model, only the employer's tablet (draw ratio = 5.0) statistically significantly explained the experience of success in implementing remote teaching. Considering the relationship between the use of remote teaching tools and workload, including all the remote teaching tools in the same logistic regression model, only the participants' own desktop computers had a statistically significant effect on workload, increasing the experienced workload somewhat (traction ratio = 0.9, p = 0.024). Thus, the overall picture of the dependencies observed in the cross-tabulations (Tables 1 and 2) was also maintained in the logistic regression models, as the tools provided by employers increased the experience of success, whereas the use of one's own tools seemed to be related to a perceived increase in one's workload.

What kinds of technological pedagogical skills do teachers need when implementing remote teaching?

In the evaluation of technological competence areas based on the TPACK theoretical model, the teachers assessed their own technological pedagogical competence as being between satisfactory and good ($\bar{x}$ = 3.6) (Figure 3).

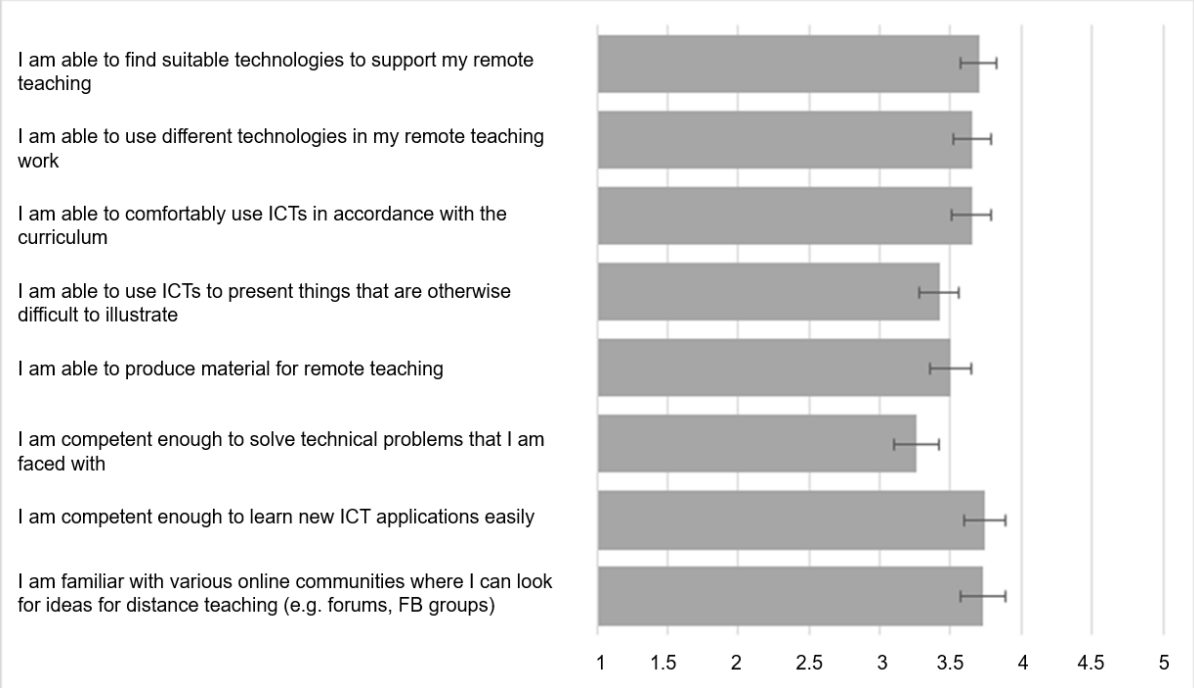

Figure 3: respondents' assessments of their own ICT skills (averages and 95% confidence intervals) (1 = I do not have these skills; 2 = My skills are limited; 3 = My skills are satisfactory; 4 = My skills are good; 5 = My skills are excellent)

The survey results indicate that the main challenges in terms of technological expertise were solving technical problems, using ICT to present difficult-to-illustrate issues and producing remote teaching

materials, all of which had an average of less than 3.5. In the evaluation of the TPK competence area based on the TPACK theoretical framework, the teachers assessed their skills as satisfactory in the context of remote teaching (Figure 3).

The survey results indicate that the main challenges in terms of TPK competence were the use of ICT in the peer assessment of remote teaching, the design and implementation of learning situations to allow students to use one another's thoughts and ideas, and the planning of teaching situations in which the learners work in pairs or groups (Figure 4). In all of these, the mean was below 3, i.e. between low and satisfactory. None of the averages of any of the questions measuring technological competence or technological pedagogical competence reached the value of 4, i.e. good competence.

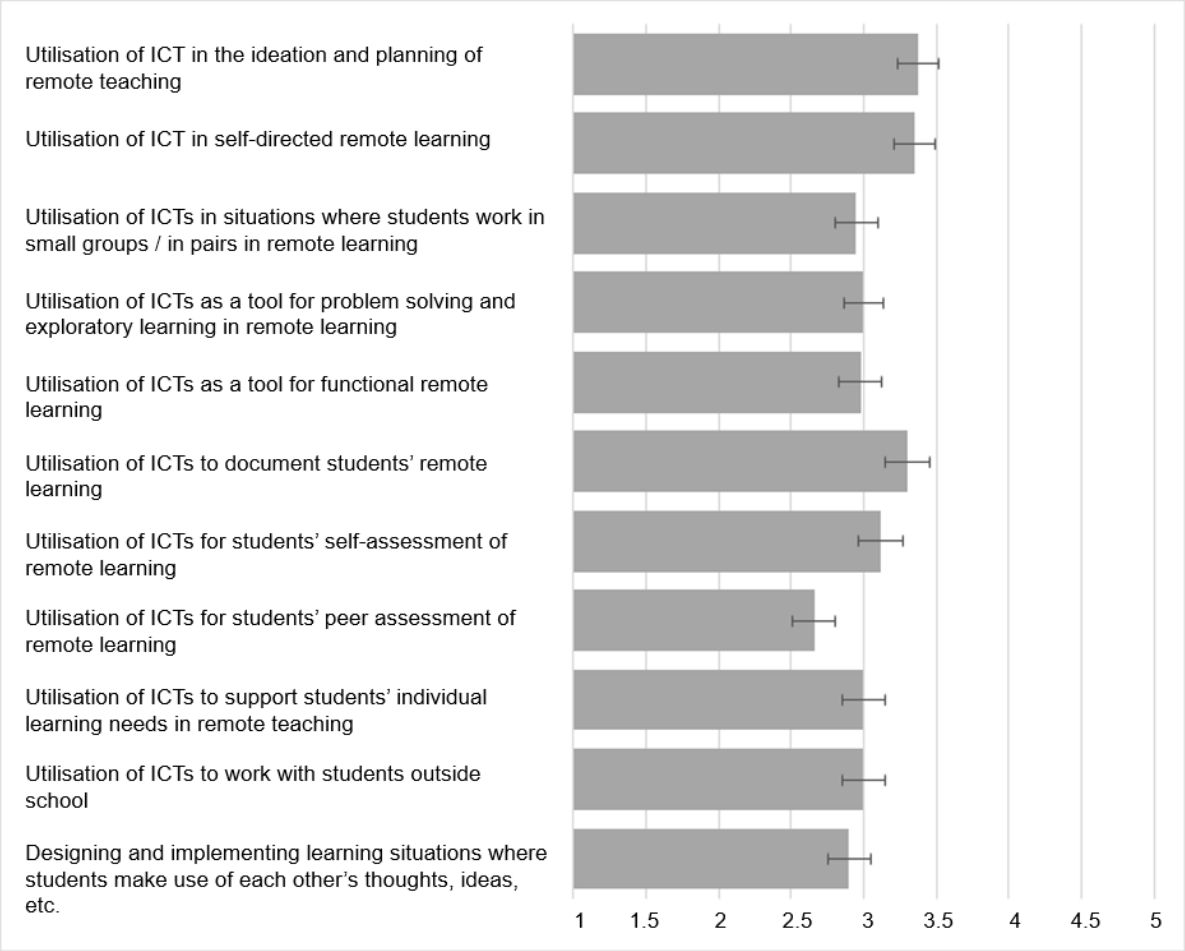

Figure 4: respondents' assessments of the design and implementation of learning situations (means and 95% confidence intervals) (1 = I do not have this competence; 2 = My competence is limited; 3 = My competence is satisfactory; 4 = My competence is good; 5 = My competence is excellent)

Overall, these findings highlight the teachers' technological and technological pedagogical competence that did not reach adequate levels. Moreover, the findings point to the teachers' increased workload experiences, which are linked to the use of their own digital tools, whereas the tools that their employers provided them were linked to the teachers' experiences of success at remote teaching. In the following section, the findings are discussed in light of previous research, and future research developments and directions are presented.

Discussion

Teachers' remote teaching experiences

In this study, we investigated the remote teaching experiences of teachers in Lapland, their self-assessed technological pedagogical competencies and their need for support. The results show that teachers in Lapland had both positive and negative experiences of switching to remote teaching in the spring of 2020. The findings reflect a difficult situation that caught the entire school system by surprise. Little time was available for the transition to remote teaching, which prevented teachers from preparing adequately for the change. Municipalities varied greatly with regard to how prepared they were for the transition to large-scale remote teaching. However, the teachers reported that they have generally been well supported in the change, which has been crucial in assessing the success of the transition.

Although the teachers' experiences of implementing remote teaching were largely positive, they would have welcomed more training and time to familiarise themselves with the implementation. The teachers felt that their workload increased and that they encountered both pedagogical and technological challenges in their teaching, especially concerning differentiation of teaching and students' motivation and self-control. Not all students were motivated by remote teaching and some students were also difficult to reach from time to time. Nevertheless, the teachers felt that remote teaching had positive effects on the development of their own and their students' ICT skills. They also observed that some students benefited from remote learning. These results are in line with those of studies that have examined teachers' remote teaching experiences. The challenges most commonly experienced by teachers are related to the design and implementation of teaching and interaction with students (Beardsley et al., 2021; Perifanou et al., 2021) as well as an increased workload (Beardsley et al., 2021). At the same time, remote teaching has been found to have positive effects (König et al., 2020).

Ahtiainen and colleagues (2020) obtained similar results regarding teachers' remote teaching experiences in a joint study by the Universities of Tampere and Helsinki, which targeted primary schools throughout the country. The teachers said that they faced challenges in teaching and reaching some students. They also encountered technical problems. These challenges were partly due to the students' lack of devices and reliable network connections. Furthermore, the teachers reported that their digital skills evolved during the spring of 2021 (Ahtiainen et al., 2020). They predicted that the teaching arrangements for exceptional circumstances would affect the arrangements for their own teaching in terms of contact teaching (Ahtiainen et al., 2020). According to a study by Tanskanen et al. (2021), teachers initially experience an increase in workload with the adoption of new remote communication methods, but in the longer term, development is seen as positive.

Our research complements previous research on job satisfaction (Ilmarinen, 2006; Ojala and Ahonen, 2005) by emphasising the importance of using the tools provided by employers, as it affects the perceived success of teachers' work. The results we obtained show that the use of teachers' own digital tools increased their workload.

Teachers' technological pedagogical competencies and need for support

In Finland, the level of digital tool usage in schools has generally been found to be good. Teachers receive technical support, if necessary, and they generally possess sufficient pedagogical skills to use basic digital tools in teaching (Hietikko et al., 2016; Kaarakainen et al., 2017; Tanhua-Piiroinen et al., 2016). Based on the TPACK model, the research material was analysed with a focus on the dimensions of teachers' technological and pedagogical competencies, which, according to the survey results, were perceived to be the weakest in terms of remote teaching implementation (Figures 3 and 4). The TPACK model generally describes the aspects of a teacher's technological pedagogical content knowledge and the relationships between them. The aim of this study was primarily to concretise such factors that should be considered in the in-service training needs of schools and teachers in the county of Lapland and in the development of teacher education (Finnish National Agency for Education, 2021, p.90).

The research results indicate that in the area of teachers' technological competencies, both the *technical* and *substantive* content-related dimensions were found to be satisfactory. Furthermore, based on the research material, two factors were outlined, defined as the *communal* and *collaborative* dimensions of teachers' pedagogical competencies (Figure 5).

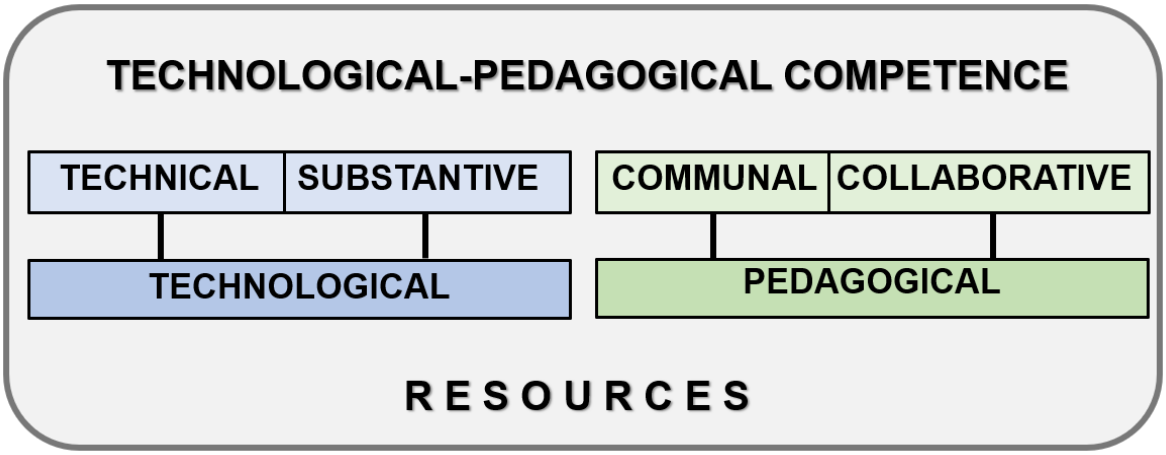

Figure 5: dimensions of teachers' technological pedagogical competencies

The technical dimension (TK) encompasses a teacher's ability to solve technical problems in the implementation of remote teaching. This means that teachers are required to have skills not only in using digital tools but also in resolving the technical challenges encountered when implementing remote teaching. The substantive dimension describes a teacher's technological competence, which involves the ability to apply digital teaching and learning materials to remote learning and to illustrate what is being taught using technology. The substantive dimension requires the teacher to produce and build their own digital material and implement remote teaching.

Teachers had a fairly good knowledge of the use of digital tools (TK) in remote learning, meaning that they were familiar with a number of technologies and knew how to use them in the design, implementation and evaluation of remote teaching. However, the teachers' TPK skills were inadequate, i.e. there were shortcomings in their skills in implementing more comprehensive remote teaching. The areas for development were related to the use of ICT in students' communal and collaborative

dimension or, in other words, group and pair work, exploratory learning and problem solving, functional learning and peer assessment in remote teaching. Thus, most teachers were able to utilise technology, but the TPACK theoretical model illustrates how the balance between technology, content and pedagogical competencies is key to successful remote teaching.

Our results support the information found in previous studies that the digital leap has been implemented in Finland in various ways (Kaarakainen et al., 2017; Tanhua-Piiroinen et al., 2016). Teachers' competencies largely differed, and before the sudden transition to remote teaching, not all teachers had the time to develop sufficient technological and pedagogical competencies. Similar results were obtained, inter alia, by Perifanou and colleagues (2021), who found that the Greek teachers who participated in their study had considerable shortcomings in both technological and pedagogical skills.

The findings can also be interpreted using Kyllönen's (2020) model of pedagogical acceptance and use of teacher technology. In the model, a teacher's internal abilities—their technology capabilities—contribute to technology uptake while lowering the threshold for learning to use technology; the enablers in this case include external resources, such as employer support and the use of personal digital tools.

A report by the Finnish National Agency for Education (2021, p.91) states that online remote learning requires different pedagogical methods from teachers. In the implementation of remote teaching, the primary pedagogical challenge for them was the planning of learning situations, in which the aim was to utilise both communal and collaborative work methods. The technical dimension of teachers' technological competencies has a significant association with the use of remote teaching pedagogy. The report by the Finnish National Agency for Education (2021, p.44) states that a positive situation in terms of the digital tools available provides a better starting point for the development of teachers' digital pedagogy. Furthermore, the report indicates that developing the use of technology in teaching and pedagogy separately is challenging (Finnish National Agency for Education, 2021, p.116). Based on the results of this study, we conclude that teachers have strong content competencies related to their own fields, subjects, pedagogy and didactics.

This study has some limitations. First, the sample size was small, and it covered a limited area. Second, the response rate was relatively low, and because of contextual differences, the results should be interpreted with caution, even though similar results were found internationally. In the future, using other sampling techniques, such as snowball sampling, would be useful for recruiting survey respondents. Aside from quantitative data, more qualitative data could be gathered, for instance, by interviewing teachers regarding their remote teaching experiences and self-assessed digital competencies.

Conclusion

The results of this study can be used in the research and development of in-service training for targeted teachers, in the improvement of teacher education and in national and international comparisons of teachers' remote teaching skills. Moreover, the results are beneficial in the current situation in which teaching has returned to classrooms. The same digital tools adopted for remote teaching can still be used after the pandemic to support students' learning. The findings also show the need to further examine remote teaching, remote learning and different ways of implementing remote teaching and

technological pedagogical methods in order to develop teaching and learning cultures alongside changes in societies and technologies. Teachers' skills are developed through the simultaneous interactions of different factors. In the future, learning more about the connection between the tools used by teachers and their self-assessed competencies from their experience of success and their workloads would be useful. Furthermore, the findings pointed to the importance of employer provided technology as it has an impact on the teachers' feelings of success at work, whereas using one's own devices was associated with diminished feelings of success and increased feelings of workload. This is a useful insight from this study context that, if verified by wider studies, could inform future policy development.

Reflecting on the findings of current and previous studies, we recommend that municipalities invest in understanding the preconditions for remote teaching and providing digital tools and technological pedagogical training for teachers. The purpose is to ensure that teaching uses equal and high standards in all classrooms and is in line with curriculum goals and the national digital educational strategy. In teacher education and in-service teacher training, attention should be given to updating technological and pedagogical skills in order to achieve the national strategy in practical schoolwork. Because teachers' technological competencies and interests in technology use vary and technologies advance rapidly, technological pedagogical training should occur at the individual and school levels at all times. In this regard, pre- and in-service teacher training is a highly important factor in staying abreast of advancements. These recommendations are consistent with previous studies that have highlighted the need for the organisation of technical and pedagogical training for teachers and teacher students (König et al., 2020; Perifanou et al., 2021). This study highlights the role of digital tools in teachers' job satisfaction. Successful and high-quality remote teaching requires, first and foremost, adequate and appropriate working digital tools and resources for both teachers and students. The development of remote teaching should also be seen as a teacher's personal investment in their own technological pedagogical skills.

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Appendix 1

Survey questions in English, modified from Kyllönen, Kukkonen, Valtonen, Vesisenaho and Häkkinen (in preparation):

1.My answers may be used for research purposes (yes/no)

EXPERIENCES

2.I received support during the TRANSITION to remote teaching (you can choose several) (Leaders/Colleagues/Community technical support/Social media/Elsewhere, where?)

3.In what things did you need more support during the TRANSITION?

4.What kinds of technical tools do you have? (Desktop computer (own)/Desktop computer (from work)/Laptop computer (own)/ Laptop computer (from work)/headset (own)/headset (from work)/smart telephone (own)/smart telephone (from work)/tablet computer (own)/tablet computer (from work)/something else/none of these)

5.What kinds of technical solutions did you use for the evaluation of students' learning?

6.How did you plan remote teaching (alone/in cooperation with the other teachers/other kinds of solutions, what kind?)

7.Did you need more support in the execution of remote teaching? If so, what kind of support?

8a. How much was it possible to take into account the special needs of the pupils in remote learning/teaching? (not at all/very little/somewhat/a lot/very much)

8b. How stressful did you feel your work was during the remote teaching period? (not at all/very little/somewhat/a lot/very much)

8c. How successful do you feel your remote teaching period was? (not at all/very little/somewhat/a lot/very much)

8d. What are the positive aspects of remote teaching?

8e. What kinds of problems did you encounter with remote teaching?

8f. What remote teaching practices would you like to use in the future?

TECHNOLOGICAL COMPETENCE

9. (scale 1-5, 1 = i cannot; 2 = i can little; 3 = sufficient knowledge; 4 = good knowledge; 5 = excellent)

I am able to use different kinds of digital solutions in remote teaching

I am able to use digital solutions based on the curriculum objectives

I am able to use digital solutions for demonstration of abstract and difficult to visualize subjects

I am able to produce digital material for remote teaching and learning

I am able to find solutions when difficulties appear with technical issues

I am able to learn easily new digital solutions

I know various online networks from which to find ideas for remote teaching

TECHNOLOGICAL PEDAGOGICAL COMPETENCE

10.I know how to use digital solutions: (scale 1-5, 1 = I can not; 2 = a bit; 3 = sufficient; 4 = good; 5 = excellent)

to support the ideation and planning of remote learning

to support self-directed remote learning

to support pupils' work in small groups and pairs in remote learning

to support problem solving and inquiry-based remote learning

to support action-based remote learning

to support documenting students' remote learning

to support students' self-evaluation during remote learning

to support students' peer-evaluation during remote learning

to support the students' individual learning needs during remote learning

to support the students' learning activities outside of school

to support students' idea and knowledge exchange

11.What kinds of positive aspects are there in remote teaching?

12.What kinds of problems did you encounter in remote teaching?

13.What remote teaching practices do you want to use in your future work?

DEMOGRAPHICS

14.Age (20-25/26-30/31-35/36-40/41-45/46-50/51-55/56-60/61-65/66-70)

15.Years of work experience (0-5/6-10/11-15/16-20/21-25/26-30/31-35/36-40)

16.Municipality of workplace (Enontekiö/Inari/Kemi/keminmaa/Kittilä/Kolari/Muonio/Pelkosenniemi/Pello/Posio/Ranua/Rovaniemi/Salla/Savukoski/Simo/Sodankylä/Tervola/Tornio/Utsjoki/Ylitornio)

17.Education (primary school teacher/subject teacher in basic education/subject teacher in upper secondary education/special education teacher/early childhood education teacher/I do not have teacher qualification/principal)

18.What kind of support material and supplementary education would you like the project to provide for you?

Appendix 2

Theme: Needs for support in transition to remote teaching	**Frequencies**
training, support, and guidance in transition to remote teaching regarding different applications	22
common alignments for execution of remote teaching	8
more time in transition to remote teaching	8
collaboration with colleagues: sharing experiences, common planning, support	5
tools for remote teaching: mobile and laptop from employer; certain applications (etc. WhatsApp)	3
single comments: guidance for students and parents; suitable learning material	
Theme: Tools for learning evaluation	
Google forms: tests	27
computer (personal/employer's)	25
phone	23
Google classroom: assignment return	21
WhatsApp	20
Teams	13
Google drive	7
Google meet	5
textbook author's online material	3
Quizlet	3
pen and paper	2
Kahoot	2
single responses: Bingel, Youtube, Edpuzzle, textmessages	
Theme: Needs for support in implementation of remote teaching	
training, support, and guidance in execution of remote teaching	18
collaboration with colleagues: sharing experiences, common planning, support	9
better tools for remote teaching	8
common alignments for implementation of remote teaching	5
Theme: Positive aspects of remote teaching	
some students benefited from remote teaching, learning results improved (chance to proceed at one's own space, better concentration, lack of social pressure, peace at work)	26
improvements in teachers' ICT-skills	25

advantages in differentiation and individualisation of teaching	15
increase in students' motivation, responsibility and self-control	14
increased depth in relationships between teachers and students	9
possibility for teachers to concentrate on teaching	9
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functional tools, material and Internet connection	4
working communication with guardians	3
single mentions: a shortened way to work; safety	
Theme: Problems with remote teaching	
technical problems	39
difficulties in reaching pupils and keep contact; absences; undone assignments	32
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challenges in supporting students' learning and self-control as well as differentiation of teaching	12
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parents' inability to support student during remote teaching	8
difficulties in following students' lesson work	6
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single mentions: excessive teacher-centeredness; discontinuous practices in different schools	
Theme: Utilisation of remote teaching in future	
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organising remote teaching for some students when necessary	6
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single mentions: executing interdisciplinary learning modules online; remote meetings with the entire class	