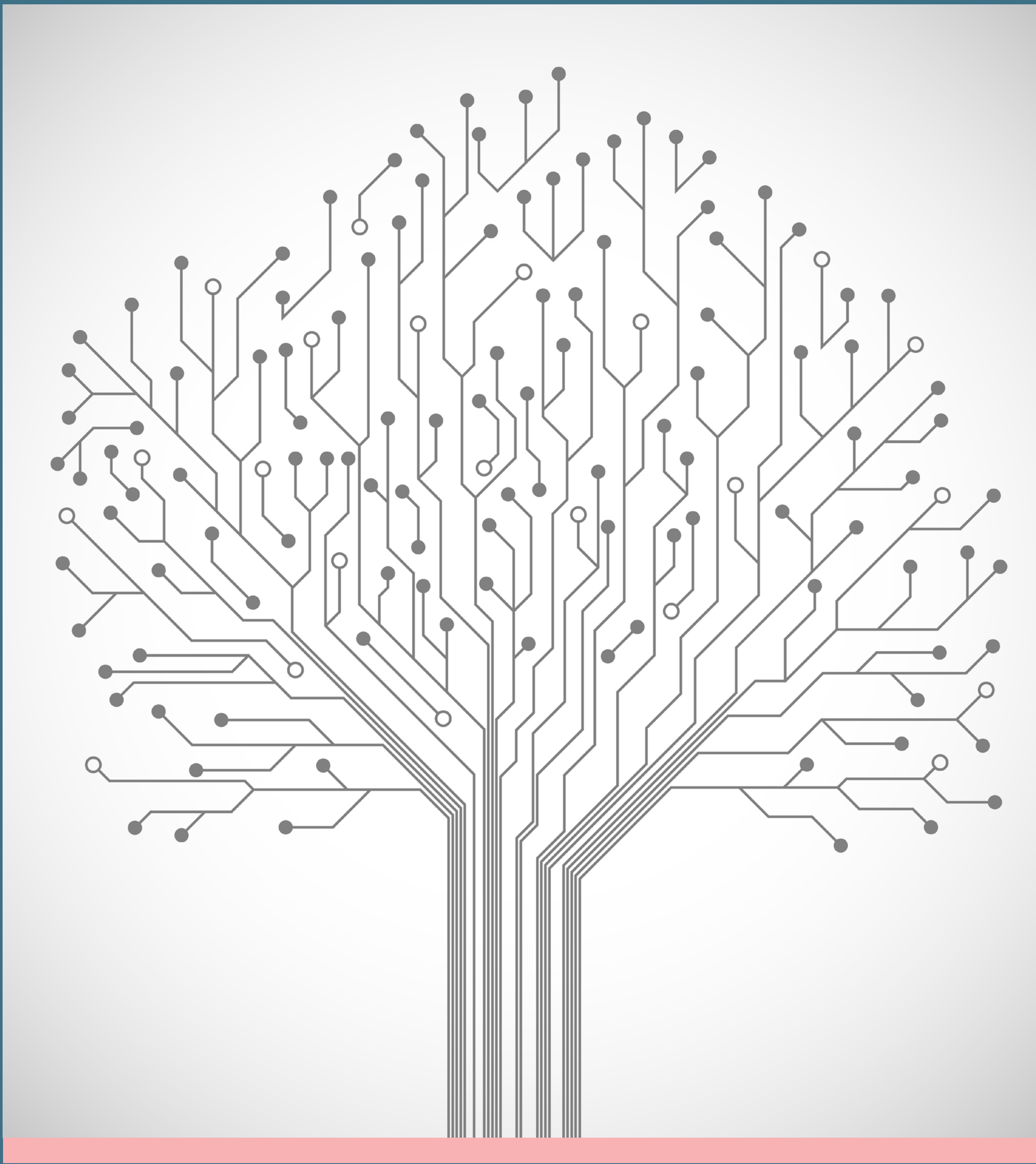


The impact of digitalisation on learning situations, learning and learning outcomes in lower secondary schools

Initial results and recommendations of a national research project

Authors

Sanna Oinas
Mari-Pauliina Vainikainen
Mikko Asikainen
Natalija Gustavson
Joona Halinen
Ninja Hienonen
Carita Kiili
Nestori Kilpi
Satu Koivuhovi
Laura Kortesoja
Reijo Kupiainen
Meri Lintuvuori
Cristiana Mergianian
Ilona Merikanto
Minna Mäkihonko
Faruk Nazeri
Laura Nyman
Kukka-Maaria Polso
Oskari Schöning
Annika M. Svedholm-Häkkinen
Sanna Vanhanen
Risto Hotulainen

Cover and visual appearance: Esko Lindgren
English version of the text: Cristiana Mergianian
Publishers: Tampere University and University of Helsinki
ISBN 978-952-03-2782-8 (online version)

Publication year 2023

In Finnish primary schools, teachers' pedagogical freedom and varying digital skills influence the use of technology in classrooms [1]. Furthermore, conflicting research evidence creates uncertainty when choosing digital devices and learning environments at the municipal, school and classroom level [2]. Researchers have reported on both the disadvantages but also on the benefits of the use of digital devices for children and young people's development; the focus on communicating with friends while doing homework is detrimental to concentration, but the use of well-designed digital materials in education promotes the learning of new knowledge and skills [3]. As citizenship and participation in everyday life and work now require the use of technology, it is important to study the impact of digitalisation on young people's learning, learning outcomes and learning situations in schools. Studying the impact is difficult due to the multiple interconnected phenomena, but the DigiVOO research project addressed this challenge by applying a variety of research designs and related empirical data within the same large-scale project. The research groups from the Universities of Tampere and Helsinki carried out this study on the impact of digitalisation on learning situations, learning, and learning outcomes of lower secondary school students on assignment from the Ministry of Education and Culture.

This summary report about the DigiVOO initial results first presents the data collected for and utilised in the study (see Tables 1 and 2) and then answers the research questions set for the project in the original assignment. The summary concludes with a set of findings and recommendations (pages 17-23). The research findings and the underlying analyses will be published in detail in a subsequent, larger peer-reviewed research report.

The digitalisation of education refers not only to the integration of technology in classrooms but also to a change in pedagogical practices [4]. Since the current Core Curriculum for Basic Education 2014 emphasises the active role of the learner themself in the learning process [5], this study looked at the implementation of digitalisation from the perspective of the learner's agency. A student is an active agent when, with the support of the teacher, he or she sets goals, regulates his or her own learning and monitors his or her progress by solving problems in collaboration with others [6]. The sub-studies of our research project provided preliminary indications that students' active agency, i.e., working towards self-imposed goals, was rarely supported when using digital devices and environments. Thus, although technology is part of every school day and seems to have been integrated into classrooms quite effectively, no change in pedagogy was observed in this study. The question is whether digital devices and environments are being used to their full potential in schools. In the future, in-service training for teachers should focus on how to improve the use of digital technologies. Furthermore, if change is considered important, more research is needed on how to utilise technology in a student-centred way.

Sanna Oinas, Risto Hotulainen & Mari-Pauliina Vainikainen

1 Leino, Puhakka & Niilo-Rämä 2021
2 Mertala, Moens & Teräs 2022; See, Gorard, Dong & Siddiqui, 2022
3 till exempel Vedechkina & Borgonovi 2021
4 Pettersson 2021
5 Opetushallitus 2014, sid. 17
6 Oinas 2022; Opetushallitus 2014, sid. 17

DATA PART 1: NEW DATA COLLECTED DURING THE PROJECT

The nationally representative longitudinal study

The initial sample for the national follow-up survey for the 2021-2022 school year included 15562 pupils from 146 schools. The sample was randomly stratified by Statistics Finland to ensure representativeness by region, type of municipality and school size. Schools were divided into three groups, with participation of either seventh, eighth or ninth grade pupils. The assessment covered all pupils in the school in the relevant grade level. In the 2021 autumn semester, 83 schools with 7745 pupils took part in the assessment. Although the data loss was quite large, the data were still well representative of the different regions of Finland and school types. The relative proportions of pupils from different backgrounds in the data were well in line with the statistics for the country as a whole. Pupils completed a 90-minute assessment battery containing a wide range of different competency tasks (mother tongue and mathematics as defined in the curriculum, programming, interactive problem solving, multiliteracy and adaptive mathematical thinking) and questionnaires measuring attitudes and beliefs. In addition, the data cover the assessment log data recorded during the assessment period.

The next data collection took place in January-February 2022. The second measurement was only one lesson long, during which students completed a shortened set of tasks. The final assessment was carried out in May 2022, with a 90-minute assessment battery, which was very similar to the initial measurement. Slightly fewer students participated in the final measurement than in the previous measurements, but the coverage of the data remained good. The autumn and spring assessments also comprised teacher surveys that were carried out in the participating schools.

The intensive data used in the DigiVOO study

In one of the target schools of the intensive study, mobile surveys were conducted after each lesson for a period of five full school days, plus the day when the survey was introduced in classrooms during the morning lessons. The surveys included questions measuring the digital nature of the lesson, motivation and group dynamics. In this school, all pupils of secondary school age (n=247) were invited to take part in the survey, which ultimately involved 118 pupils from different grade levels. The data was collected with pupils' own smartphones using the m-Path application. Lesson surveys were administered at the end of each lesson and an open-ended survey was available for half an hour (15 minutes before and after the lesson). The questionnaire was individually targeted according to the student's own timetable and different students therefore received a different number of questionnaires to complete. During the survey period, a total of 1488 responses were received, i.e., an average of around 13 responses per pupil.

In the three schools, the intensive study involved large-scale interviews (N=23 + 19 + 18 pupils) and observations (8 + 7 + 6 pupils). In two of the schools, the study also included a digital literacy test taken by the pupils (N=413).

The DigiVOO study used a wide range of assessment data. Some of the data were collected for the DigiVOO project during the 2021-2022 academic year. In addition to the new data, a number of previous assessment data were utilised, which allowed the analysis to be extended to include back to the beginning of the millennium.

TABLE 1. Data collected during the DigiVOO study in 2021-2022

Data	Participants	What was studied?	Data used in substudy
I: Nationally representative longitudinal study	Originally 7745 7th to 9th graders from 83 schools around Finland in October 2021, February 2022 and May 2022	Pupils' competences in mathematics, language of instruction and problem solving; pupils' conceptions of learning, themselves as users of digital technology, and the use of digital technology in schools	Substudies 2–5 and 7–12 (pages 16-20)
II: Teacher survey	944 teachers from 72 schools participating in the national longitudinal study in autumn 2021, and 303 teachers from 56 schools in spring 2022	The connections of teachers' background and subjects taught with the utilisation of digital technology in teaching	Substudy 1 (page 16)
III: Mobile surveys	118 students	The effects of digitalisation on pupils' experiences of individual lessons and how digitalisation influences the group dynamics of learning situations	Substudy 13 (page 21)
IV: Digital literacy test	413 pupils	Pupils' competences in the different areas of digital literacy and critical thinking	Substudy 15 (page 22)
V: Observational and interview data	21 lessons in three lower secondary schools. Altogether 50 7th and 8th grade pupils participated.	How digital technology was utilised in lessons. Pupils were interviewed about their conceptions on learning in digital environments.	Substudy 14 (page 21)

DATA PART 2: LOOKING BACK TO THE BEGINNING OF THE MILLENNIUM

Learning to learn assessment data

The DigiVOO project utilised the national 9th grade learning to learn assessment data from 2001 and 2012. In addition to cognitive tasks and belief questionnaires, the assessments included questions on students' use of computers and the internet. In addition, these assessments included experimental parts to test the impact of the assessment method on students' test performance. In 2001, the sample included 82 schools whose ninth graders (N=8765) participated in the assessment. In 2012, the sample consisted of 82 schools with 9th graders (N=7800) taking the assessment. Of the schools participating in the 2012 spring evaluation, 74 were the same as in 2001. In both years of the study, about half of the participants completed the tasks in a printed exercise book and half using a computer. The analyses in this chapter include only those pupils who used the 2001 version of the assessment battery, as the new 2012 version did not include the questions on the use of digital technology.

PISA data

The project used data from all rounds of the PISA assessments (2000-2018) in Finland. As the main focus was on the 2018 data, the other data were also examined from the perspective of reading literacy, which was the main assessment area in 2018. Previously, reading literacy had been the main assessment area in 2000 and 2009. The analyses included 5649 students from 2018, 5882 from 2015, 8829 from 2012, 5810 from 2009, 4714 from 2006, 5796 from 2003 and 4864 from 2000. The data are described in more detail in the Finnish first results (Arinen & Karjalainen 2007; Kupari et al. 2004; Kupari et al. 2013; Leino et al. 2019; Sulkunen et al. 2010; Vettenranta et al. 2016; Välijärvi et al. 2001). In the present study, the data were used not only for literacy outcomes but also for the use of digital literacy in a variety of contexts as measured in the ICT surveys. The PISA 2018 data also included information about the intensified or special support received by pupils, collected as a national option for the first time.

TABLE 2. Existing data utilised in the DigiVOO study

Data	Participants	What was studied?	Data used in substudy
PISA data from all assessment cycles in 2000-2018	Number of pupils per year 2018: N = 5649 2015: N = 5 882 2012: N = 8 829 2009: N = 5 810 2006: N = 4 714 2003: N = 5 796 2000: N = 4 864	How digital learning in schools is related to reading literacy in different points of time	Substudy 6 (page 18)
VII: National 9th grade learning to learn assessments 2001 and 2012	Number of pupils per year 2012: N = 7 800 2001: N = 8 765	How pupils' earlier experiences in using digital environments predicted their performance on digital assessments compared to paper-based assessments when digitalisation was still rarely used in schools.	Intermediate report of the DigiVOO-study: PDF
VII: Pupil survey data on remote learning during COVID-19	Number of pupils per year 2020: 1615 2021: 1136	How the level of digitalisation of schools during 7th and 8th grade predicted pupils' learning outcomes in 9th grade	Intermediate report of the DigiVOO-study: PDF

MAIN FINDINGS

1

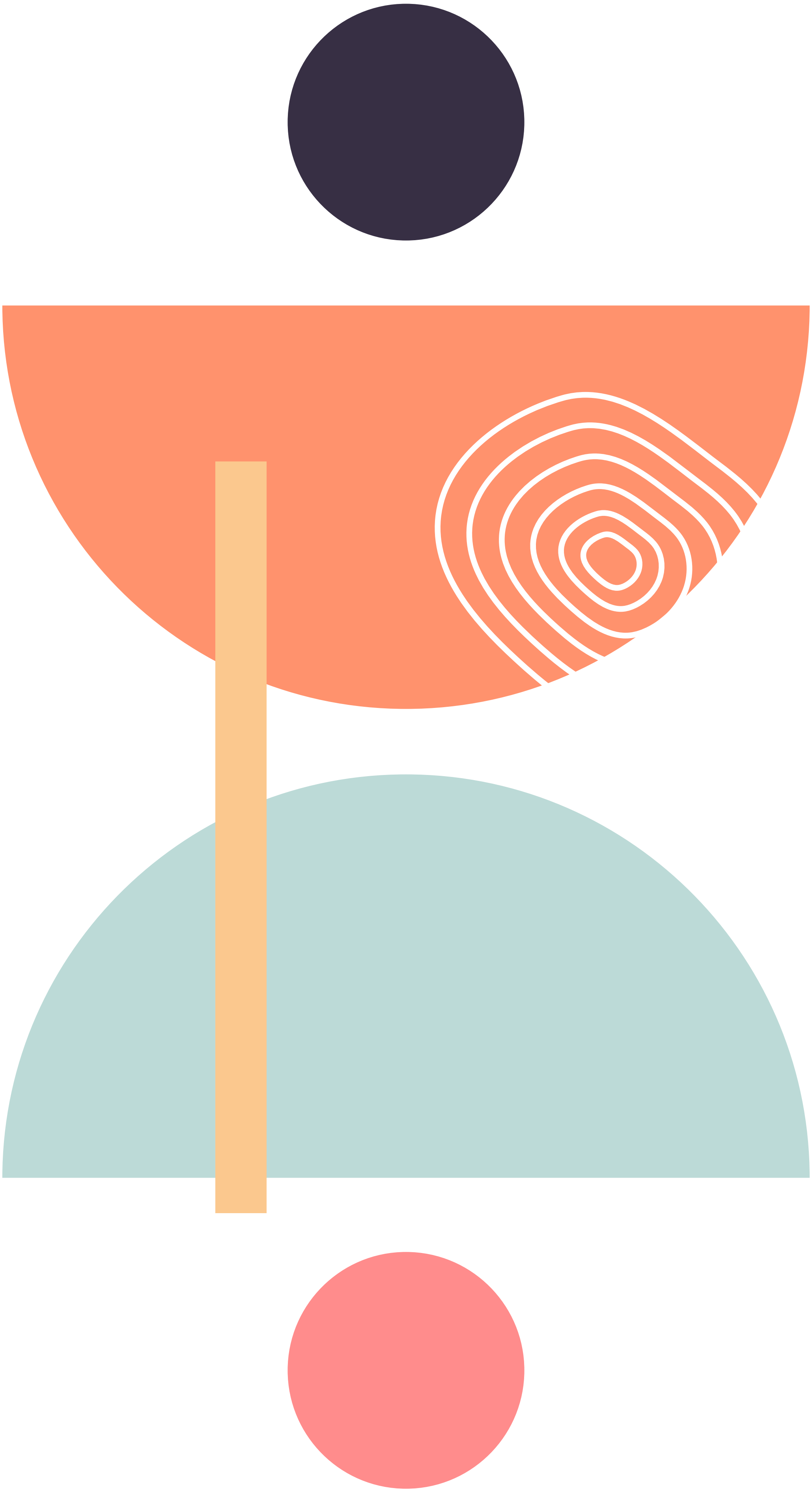
Digital technology is so far rarely used in Finnish lower secondary schools. The use is rather one-sided, focusing on information retrieval, editing and storage. Pupils are rarely active agents in lessons utilising digital technology.

2

Pupils receiving intensive or special support, pupils with an immigrant background, and lower achievers report using digital technology at school more often than other pupils. There appears to be a negative correlation between digital technology use and learning outcomes, but this relationship is largely explained by the use of digital devices for differentiation. However, the study shows that digitalisation does not impair learning results.

3

Digitalisation enables the differentiation of learning and assessment in novel ways compared to when traditional materials are used. This can increase pupils' motivation and engagement in learning situations. Task environments can be designed to provide the right level of challenge for each pupil, with tasks becoming easier or harder according to ability. An adaptive environment helps not only those who need support, but also those who are progressing more quickly. In addition, pupils can be provided with individualised feedback on their learning in a way that supports the learning process.



THE EFFECTS OF DIGITALISATION ON LEARNING SITUATIONS

1A What are the learning situations utilising digital technology and how are they different from other learning situations?

1B How are the group dynamics in digital learning situations and how are they different from other teaching situations?

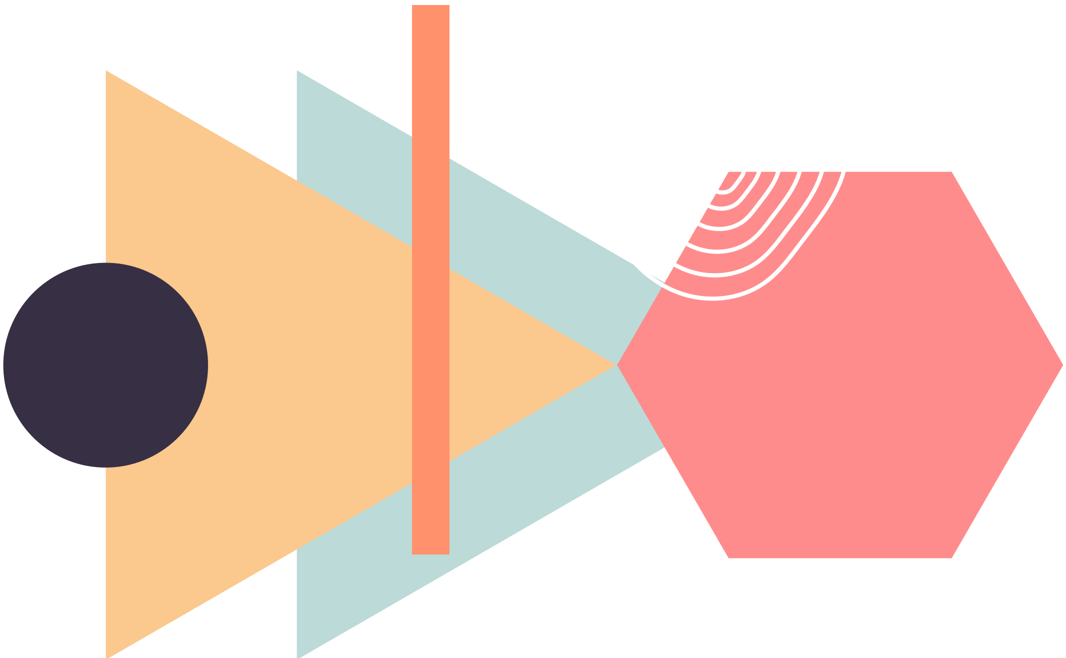
1C How is digital technology utilised in different school subjects?

During the project, the impact of digitalisation on learning situations was investigated in four different sub-studies using five different types of data. Based on a survey of teachers (N=944) and lesson observations (N=21), teachers very rarely made pupils active users of digital technologies. In the teacher survey, teachers considered that digital technologies requiring basic digital skills - such as multimedia presentations by pupils - were only used in class about once a month. In particular, teachers' confidence in their own digital skills predicted the use. Finnish language teachers were more likely than other teachers to use basic digital technologies. Digital technologies requiring advanced skills were very rarely used in schools. Advanced use was strongly predicted by teachers' confidence in their own digital skills. Mathematics teachers were the most likely to use advanced digital technologies in their teaching. Teachers' responses thus reflected the fact that programming is part of the objectives of the 2014 Core Curriculum in mathematics.

The data show that digital technology is used in schools to complete pre-structured tasks. In the interviews, pupils (N=50) expressed their wish for tasks that would allow them to produce content based on their ideas and creativity. Based on the observations, digitally delivered learning situations most often involved a digital presentation or a task where the pupil saved a photograph or a photocopy in an online environment. This means that technology was used in an instrumental way without any change in pedagogy. Gamified learning situations implemented digitally were used as breaks between other learning activities.

Based on the mobile survey data, the digital delivery of the lesson explained some of the motivation and group dynamics of the pupils (N=118) and the effects were mostly positive. Digitalisation of the lesson increased interest in mathematics and in mother tongue as well as increased pupils' effort. In contrast, in physics and English digital delivery of the lesson was associated with lower levels of effort in the lesson.

However, on average, lower secondary school pupils' ratings of their own interest and effort in different subjects were quite high. Furthermore,



when looking at the national longitudinal data (N ≈7000), a link was found between digitally delivered learning situations and social inclusion. The practice of basic digital skills in lessons was positively associated with pupils' self-concept as digital technology users and positively reflected their perceived social inclusion. However, for pupils with special needs, advanced use of digital technologies was also associated with experiences of loneliness and exclusion. The results suggest that digitally-enhanced learning situations may benefit some pupils in terms of motivation and experiences of belonging to a group but may also harm others with the opposite experiences.

In addition, differences in benefits were also found by subject. The impact of digitalisation on learning situations is therefore not clear. Like everything else in school, the use of digital devices and environments in teaching requires teachers to use pedagogical judgement, to know their pupils and to understand when and how to use technology. With technology now ubiquitous in everyday life, it is important to remember that digitalisation is reflected in learning situations and group dynamics in an uncontrolled way, including pupils' phones. In the interviews, pupils (N=50) reported that they were following social networking sites and communicating with friends, especially in lessons where phones were allowed to be used. Partly for this reason, they considered digital interaction and privacy skills to be the most important skills for the future.

THE EFFECTS OF DIGITALISATION ON LEARNING

2 A What kinds of effects do digital practices, learning environments, learning products and learning materials have on learning and how are they different from other learning?

2 B How does digitalisation influence the learning of particular pupil subgroups and their support needs?

2 C What kind of competence needs has digitalisation created for pupils and teachers?

The effect of digitalisation on learning was examined by building a learning environment utilising learning analytics. The environment included interactive and game-based tasks to explore the development of problem-solving and programming skills, as well as adaptive tasks to support the development of mathematical thinking. In the mathematical reasoning tasks, pupils (N≈4000) had the opportunity to check their solutions, which was thought to help them develop their reasoning. In addition, the potential of digitalisation was exploited in all tasks by providing personalised, real-time feedback on progress to both pupils and teachers. The aim was to investigate whether pupils' skills in mathematics and problem solving develop over the academic year to draw conclusions about digital approaches, learning environments and materials for learning. Investigating the usefulness of digital learning environments and materials is important because it is known that not all digital materials support learning. For example, some of the materials in digital learning environments commonly used by schools are built in such a way that little use is made of research on the effects of feedback on learning.

The results showed that not all pupils were interested in completing digital learning tasks on a voluntary basis, with around one in five pupils showing little interest in completing the tasks, according to the response times recorded in the log data. When looking at those pupils who did engage with the digital features of the tasks, positive improvements were observed in mathematical reasoning skills (Figure 1) and in the curriculum-based mother tongue tasks. It was also found that adaptive tasks in particular enabled pupils to perform above age-specific expectations. The possibility to check the solution to the task improved pupils' performance. The more often a pupil checked the task, the stronger the development of mathematical thinking. It was also found that ninth-grade boys performed best on mathematical reasoning tasks. Knowing that pupils progress at very different rates in the classroom, a well-designed digital task environment can support pupils' individual progress and provide progressive challenges for pupils who are further along in their learning. In the future, it would therefore be important to focus on developing a range of digital environments that support thinking and provide appropriate challenges for pupils learning at different paces.

Regarding problem solving, it was found that pupils had adopted different strategies to solve problems such as finding suitable growing conditions for plants or writing a graphical code to program a robot. In a digital environment, both systematic exploration and experimentation through trial and error make it possible to find a solution to a problem, which may support the ability of different learners to develop their problem-solving skills. However, recognising that real-life problems may not always be best approached with a trial-and-error strategy, it would be important for schools to pay attention to developing systematic thinking. With the proliferation of digital environments, there is a risk that a strategy based on unsystematic exploration will become more common and systematic thinking, which requires perseverance, will become less common if no attention is paid to training thinking skills.

The impact of digital devices and environments on learning was also studied in interviews with secondary school pupils. In all schools (N=3), pupils (N=50) agreed that they prefer to write using a computer rather than pen and paper, but for reading, they prefer paper books.

Knowing that pupils progress at very different rates in the classroom, a well-designed digital task environment can support pupils' individual progress and provide progressive challenges for pupils who are further along in their learning. In the future, it would therefore be important to focus on developing a range of digital environments that support thinking and provide appropriate challenges for pupils learning at different paces.

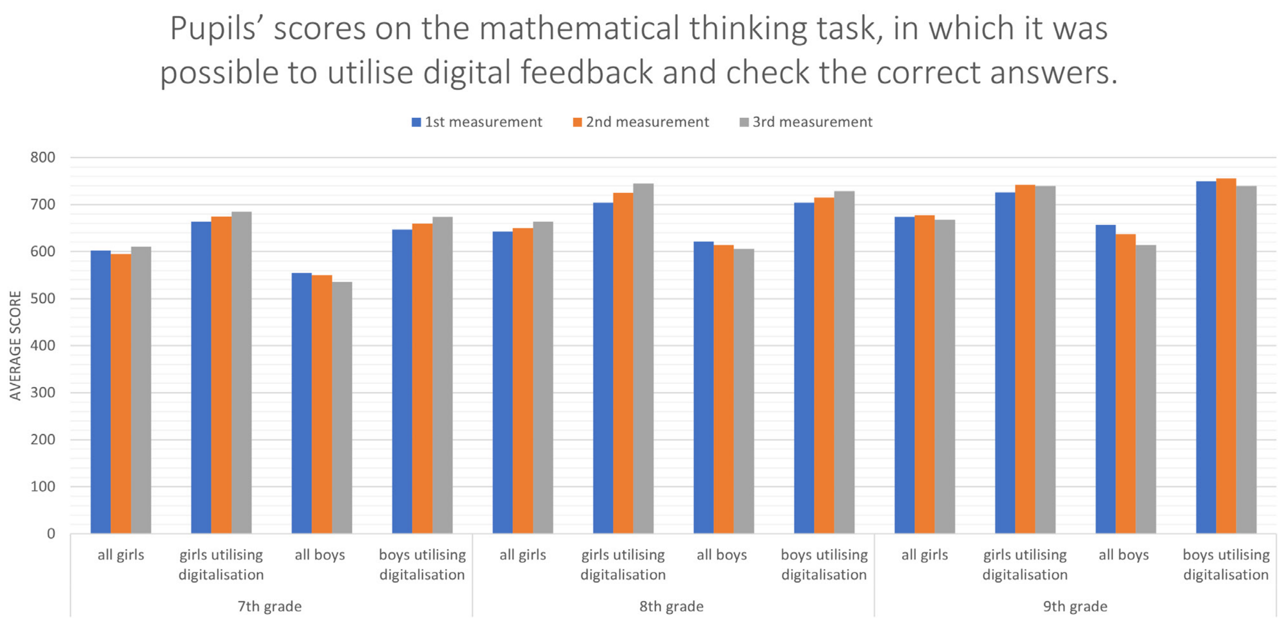


FIGURE 1: Pupils' scores on the mathematical thinking skills task. The figure shows the scores of all pupils and separately of those who utilised the opportunity to get feedback and check their answers in real time.

THE EFFECTS OF DIGITALISATION ON LEARNING OUTCOMES

3 A What kinds of effects do digital practices, learning environments, learning products and learning materials have on learning outcomes and how are they different from other learning?

3 B What kinds of effects does digitalisation have on the commitment to learning situations and motivation?

The arrival of digital devices in schools has sometimes been blamed for the decline in young Finns' assessment results since 2006. In this study both the DigiVOO data and the PISA data show that the use of digital devices is negatively related to skills at the individual level, but that an unequivocal causal link between digital devices and skills cannot be demonstrated. The phenomenon is multidimensional and can also be caused by multiple independent phenomena coinciding in time.

In the curriculum-based tasks in mother tongue and mathematics in the DigiVOO data, it was found that there was a statistically significant difference between the scores of seventh, eighth and ninth graders in both mother tongue and mathematics in the initial autumn measurement. In mother tongue, seventh and eighth graders showed a statistically significant increase in proficiency over the course of the school year, with no further difference between the groups at the end of the spring measurement (Figure 2). However, in the ninth grade, proficiency in both mother tongue and mathematics declined from the initial to the final measurement, probably due to a lack of effort on tasks in the May assessment. In mathematics, there was no statistically significant change in the performance of seventh or eighth graders at the level of the whole data set, but a gendered analysis showed an improvement in the performance of eighth grade girls during the follow-up period. In mathematics, the scores of ninth-grade boys were statistically significantly higher than all other groups at the initial measurement in the autumn, but the difference disappeared when scores declined in the spring. In mathematics, the scores of ninth-grade girls also declined during follow up. In contrast, in mother tongue, where the gender gap in favour of girls was quite large, the decline in proficiency was statistically significant only for boys, while girls' proficiency remained unchanged over the school year.

In mathematics, the differences between schools were quite small, with school explaining only 1-4% of the variance depending on grade level and time point. In mother tongue in the eighth grade, school explained up to 7% of the variation in scores at baseline, but otherwise differences between schools were small. In both mother tongue and mathematics, the use of basic digital technologies was quite strongly negatively related to proficiency at school level, especially at baseline, i.e., digital technologies were used more in schools with lower initial proficiency levels (Figure 3). In mother tongue, the negative association was still observed in the spring, while in mathematics it was no longer evident at the school level. The effects in mother tongue also weakened after taking into account pupils' background and grade level, and this may be partly explained by the fact that in

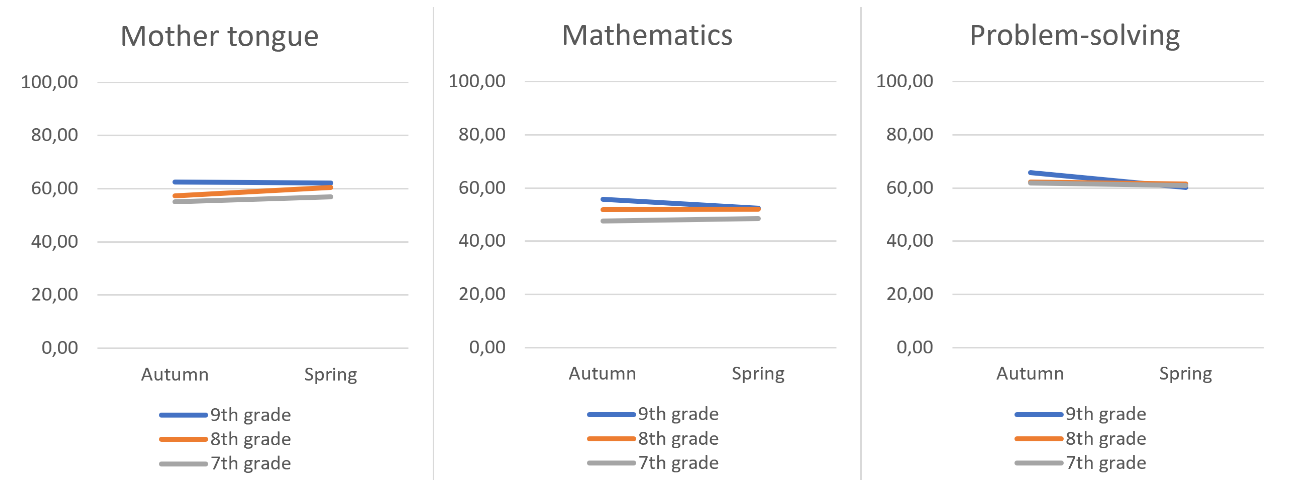


FIGURE 2: The development of performance in mother tongue, mathematics and problem-solving tasks during an academic year in the 7th, 8th and 9th grade. The figure displays percentages of correctly solved items.

the seventh grade, where proficiency was slightly lower, digital literacy was used more than in the other grades. For advanced digital technology, the effects were similar but less pronounced, and the school-level associations disappeared entirely after accounting for background in both mother tongue and mathematics.

The results thus confirm the interpretations made in the other sub-studies that digital technology seems to be used in schools primarily for support and differentiation and it is not at the expense of learning outcomes.

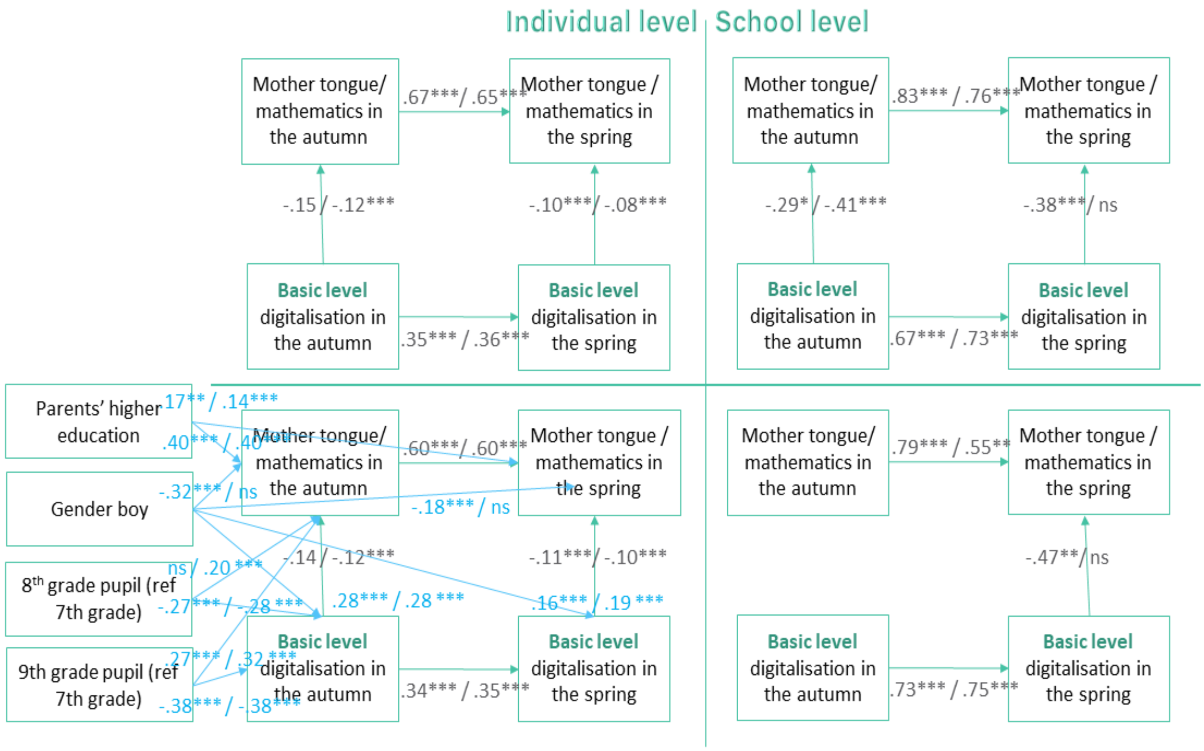


FIGURE 3: The use of digital technology as a predictor of performance in mother tongue and mathematics during one academic year.

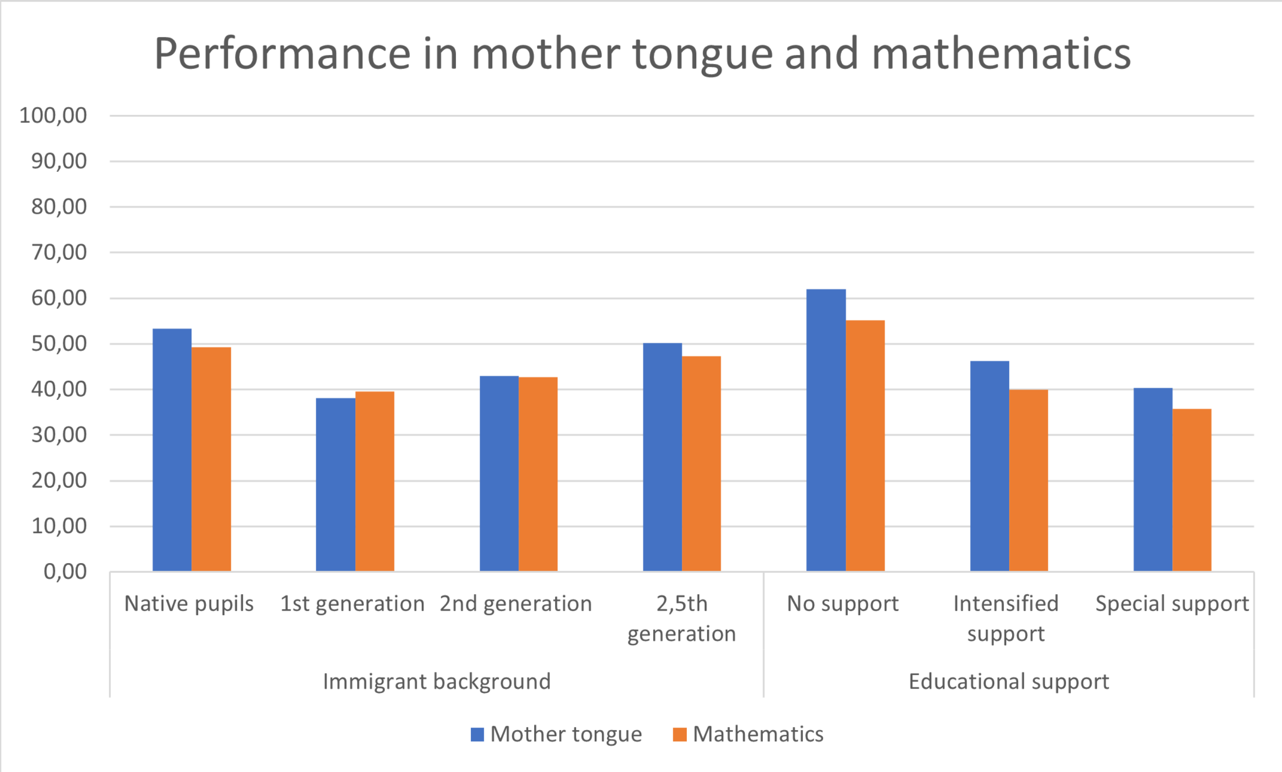


FIGURE 4: Background-related differences in learning outcomes. 1st generation immigrants are children of non-native parents born outside of Finland. 2nd generation immigrants are children of non-native parents born in Finland. 2,5th generation immigrants are born in Finland, but one of their parents is non-native.

Other sub-studies using the same data clearly show that pupils with intensified or special support needs and those with an immigrant background report using more digital technology at school (Figure 5). For pupils receiving intensified or special support, there was a negative correlation between the use of digital technology in school and performance on tasks in mother tongue and mathematics, i.e., also within these groups, digital technology seemed to be targeted most at pupils with lower levels of proficiency. For pupils with an immigrant background, the use of digital technology in school was not associated with performance in mathematics. Analyses of PISA data show that, in addition to pupils who received support, pupils who performed worse on the reading literacy assessment also reported using more digital technology at school. The PISA data show a negative association between reading literacy and digital technology use in school for all pupils, although the association was strongest for pupils receiving special support. On average, lower achievers and pupils receiving intensified or special support reported using digital technologies more often at school, which may partly explain the negative associations observed. However, this phenomenon requires further research to draw reliable conclusions. The results suggest that digital learning materials are being used to differentiate instruction for pupils with special needs and for pupils who do not speak the language of instruction in their home language. The results raise the question of how planned and teacher-pupil-centred the use of digital technologies in schools is and, on the other hand, whether digital materials are used to carry out school tasks or whether they are used alongside school tasks.

The use of digital technology in education was also slightly negatively related to pupils' proficiency in interactive problem-solving tasks at the individual level and more strongly at the school level in both the autumn and spring assessments. Differences were particularly clear at baseline, i.e., again, digital technology seemed

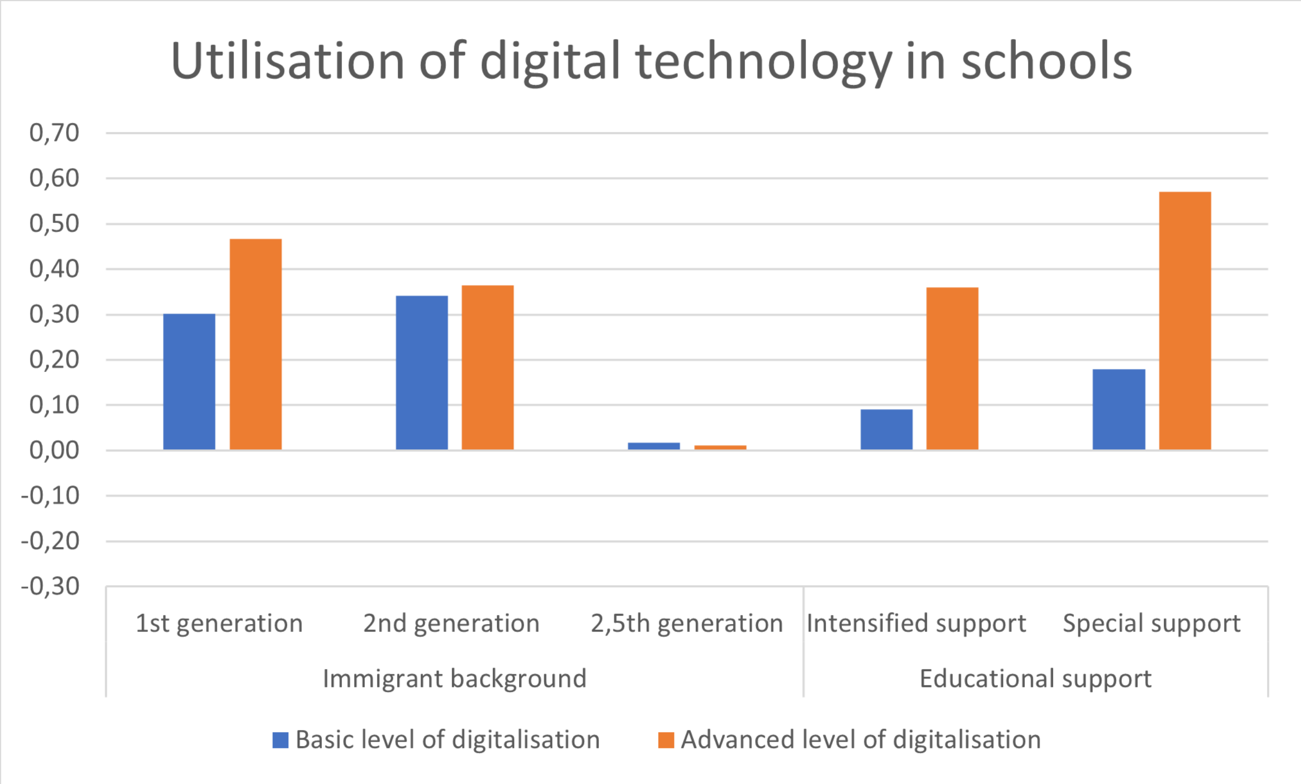


FIGURE 5: Background-related differences in the utilisation of digital technology in schools.

to be used more in schools with lower baseline skills. At the individual level, digital technology was targeted at pupils with support needs or with an immigrant background, and this again largely explained the negative association between advanced digital technology use and proficiency in problem-solving tasks. However, regarding the use of basic digital technology, taking into account pupils' background did not explain the findings. The results of the follow-up study suggest that the use of digital technology does not undermine pupils' learning outcomes in problem-solving tasks but is primarily a matter of increased utilisation of digital technology with pupils who experience different challenges in their learning.

The previous learning to learn assessment data also showed that the link between digitalisation and learning outcomes has never been straightforward. In the assessments carried out in the early 2000s, the overall performance on the online version of the test was lower than when the assessment was carried out on paper, but this may be partly explained by the technology in use at the time - the differences between online and paper versions levelled out over the next decade. However, already at the beginning of the millennium, it was found that pupils' experiences of digitalisation had an impact on their performance on digital assessment tasks. In the early digital assessments, pupils' experience of using digital technology positively explained their test scores on the online test, while for pupils who took the paper test, the use of digital technology did not significantly predict test scores. Thus, it can be concluded that in the early 2000s, pupils' use of digital technology facilitated their transition to online assessments and perhaps facilitated test-taking, giving pupils an additional advantage over others, especially when the interfaces of assessment platforms were still quite modest at the beginning of the millennium.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

PART 1 – LOWER SECONDARY SCHOOL PUPILS AS DIGITAL TECHNOLOGY USERS

01 Teachers reported infrequent use of digital technology in their teaching. They also very rarely involved pupils as active users of digital technologies. Digital technologies requiring basic skills were only used in class about once a month. In particular, teachers' confidence in their own digital skills predicted the use, and Finnish language teachers used basic digital technology more than other teachers. Digital technologies requiring advanced skills were used significantly less – almost not at all. Advanced use was also strongly predicted by the teacher's high digital self-efficacy, and mathematic teachers reported more use than other teachers. Various digital literacy projects and curriculum changes have guided teachers to use digital technologies in their teaching but completing the "digileap" would require supporting teachers' own digital skills, in-service training and conducting research on learning processes supported by digital technologies. (Joona Halinen, Oskari Schöning & Faruk Nazeri)

02 On average, lower secondary school pupils' perceptions of their digital literacy were quite positive, but the evaluations declined slightly both from one grade to the next and over the course of the school year. A small number of pupils reported anxiety about digital technology, so reinforcing basic digital skills at school could help reduce anxiety. On the positive side, the use of technologies requiring advanced digital skills increased slightly from autumn to spring, meaning that during the school year some pupils were able to try out things like programming or 3D modelling. The development of digital literacy can be compared to the development of reading skills, for example. When pupils learn to form words from letters, they need practice and adult guidance to achieve the literacy skills needed to learn. Similarly, pupils who appear to be coping with their digital devices will benefit from practice and guidance to become ready for future digital literacy. (Risto Hotulainen & Sanna Oinas)

Completing the "digileap" would require supporting teachers' own digital skills, in-service training and conducting research on learning processes supported by digital technologies.

The development of digital literacy can be compared to the development of reading skills, for example. When pupils learn to form words from letters, they need practice and adult guidance to achieve the literacy skills needed to learn. Similarly, pupils who appear to be coping with their digital devices will benefit from practice and guidance to become ready for future digital literacy.

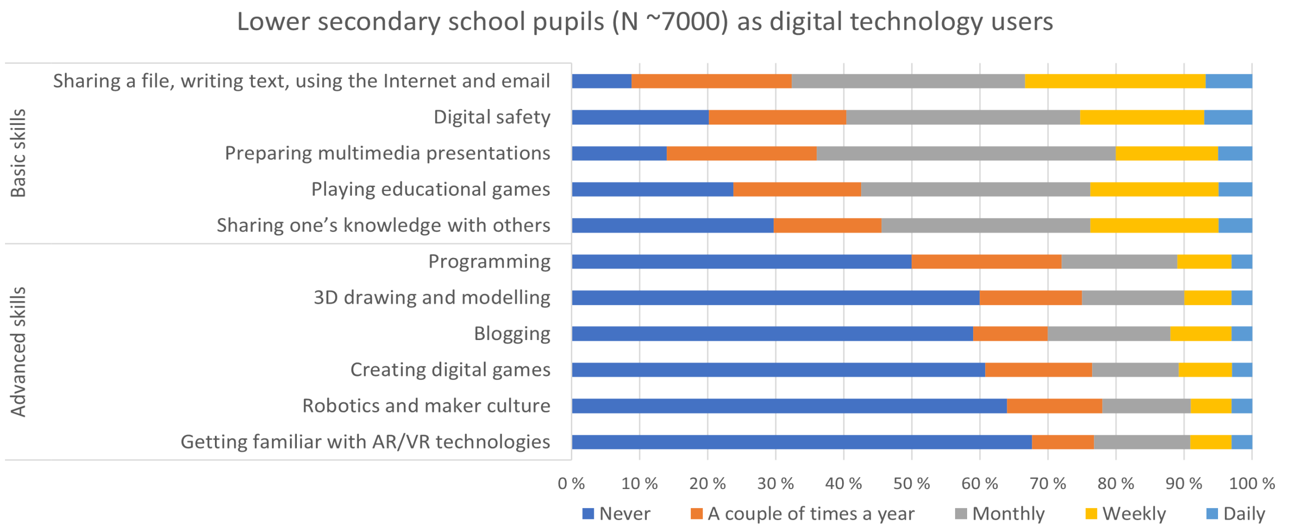


FIGURE 6. The pupils were asked to evaluate how often they had practiced the abovementioned skills in school. The questionnaire utilised the scale developed by Korhonen and colleagues (2020). The pupils answered the questions on a 7-point scale, but for the purposes of this figure, values 3 (once a month) and 4 (a couple of times a month) as well as 5 (once a week) and 6 (a couple of times a week) were combined.

03 A small minority of pupils reported very high digital stress, and just over half of pupils experienced average stress in the spring. It would be essential to identify the underlying causes of the anxiety, stress and nervousness associated with digital technology to support these pupils and develop learning environments in the best way possible. (Kukka-Maaria Polso)

It would be essential to identify the underlying causes of the anxiety, stress and nervousness associated with digital technology to support these pupils and develop learning environments in the best way possible.

04 The use of digital technology in lessons and the digital self-concept of the pupil are linked to the social inclusion experienced by pupils and, for pupils with support needs, to feelings of loneliness. Digitalisation can therefore increase positive cooperation and a sense of belonging between pupils, but it can also produce feelings of exclusion, especially for pupils receiving intensified or special support. The results concluded that practising basic digital technology skills in lessons should be seen as a way of strengthening pupils' sense of belonging and social inclusion. (Sanna Vanhanen, Minna Mäkihonko & Mari-Pauliina Vainikainen)

05 Among lower secondary school pupils with an immigrant background, the 1st generation (both themselves and both their parents were born outside of Finland) and the 2nd generation (themselves born in Finland, but both their parents were born outside Finland) were less successful than the majority population in digital skills tasks in mathematics and Finnish. Generation 2.5 pupils (themselves and one of their parents born in Finland and the other born elsewhere) performed the best on Finnish language learning tasks, but slightly worse than the majority population on mathematics tasks. Pupils with an immigrant background reported using digital technology more than the majority population. Use of basic digital technology in education predicted lower performance in mathematics only for the majority population, but the association was very weak. (Faruk Nazeri & Mari-Pauliina Vainikainen)

06 In all cycles of PISA, there was a weak negative association between the use of digital technology in schools and scores in reading literacy at the level of the whole data set. When looking at reading literacy by achievement levels, the effects largely disappeared. The lowest achievers and pupils with enhanced and special support reported using more digital technology at school. The results suggest that since the beginning of the millennium, digital technology has been used in schools for differentiation and as a means of implementing support. (Nestori Kilpi, Ninja Hienonen & Mari-Pauliina Vainikainen)

07 When the association between basic and advanced digital technology use and performance in mother tongue and mathematics was examined in relation to learning and school support, it was found that the association was negative in all groups, but it was the strongest for pupils receiving special support. On average, pupils receiving support reported using digital technology more at school and they also tended to perform worse than other pupils in cognitive tasks, which may partly explain the negative associations found. This phenomenon requires further research to draw reliable conclusions. It is important for schools to be aware of how digital learning materials are being used in schools when differentiating teaching for pupils with support needs. (Ninja Hienonen & Meri Lintuvuori)

It is important for schools to be aware of how digital learning materials are being used in schools when differentiating teaching for pupils with support needs.

08 The amount of use of digital devices or apps in lessons was not associated with pupils' self-assessed fatigue during school mornings or days. The amount of digital use in lessons was also not associated with pupils' self-reported sleep duration, bedtime, insufficient sleep or poor sleep due to schoolwork. The study found that sleep deprivation at night was associated with the use of digital devices in the evening for an unfortunately large number of lower secondary school pupils. (Laura Kortesoja & Ilona Merikanto)

PART 2 - UTILISATION OF DIGITAL LEARNING ENVIRONMENTS

Digitalisation enables the differentiation of learning and assessment in novel ways compared to when traditional materials are used. Task environments can be designed to provide the right level of challenge for each pupil, with tasks becoming easier or harder according to ability. In addition, pupils can be provided with individualised feedback on their learning in a way that supports the learning process.

09 Supporting the development of mathematical thinking is possible by developing task environments that are adapted to the pupil's level of competence and in which pupils can follow the progress of their learning to monitor their progress and check the tasks they have solved. The results showed that the more often pupils checked their solutions, the more their mathematical thinking developed over the course of the school year. It was also found that ninth-grade boys performed better on adaptive and interactive mathematical thinking tasks than their peers. Digital learning environments should be designed in such a way that they support the learner's cognitive development and active participation. This requires that learning environments are always designed based on a scientific understanding of how pupils learn. (Sanna Oinas, Mikko Asikainen & Mari-Pauliina Vainikainen)

10 Two tasks were used to measure programming skills and computational thinking, code building and debugging, and there was a positive correlation between them. On average, lower secondary school pupils were quite skilled at building code in a graphical environment, but debugging code, which requires deeper computational thinking, was more difficult. In the debugging tasks, all pupils benefited from an increased number of attempts to find the right code, while in the code building tasks, skilled pupils solved the task quickly without extra attempts based on trial and error. Boys were more skilled at code building, but girls were more skilled at code correction. It is important for schools to ensure all pupils have equal possibilities to learn to think computationally as part of their general education. (Laura Nyman & Cristiana Mergianian)

Digital learning environments should be designed in such a way that they support the learner's cognitive development and active participation. This requires that learning environments are always designed based on a scientific understanding of how pupils learn.

It is important for schools to ensure all pupils have equal possibilities to learn to think computationally as part of their general education.

11 The use of digital technology in school was slightly negatively related to pupils' performance in interactive problem-solving tasks at the individual level and more strongly at the school level in both the autumn and spring assessments. The differences were particularly clear at baseline, where digital technology seems to be used more in schools with lower baseline performance. At the individual level, digital technology was targeted more than average at pupils receiving support and pupils with an immigrant background, and this largely explained the negative association between advanced digital technology use and proficiency in problem-solving tasks. However, the pupils' background did not explain the findings related to the use of basic digital technology. The results of the follow-up study suggest that the use of digital technology does not undermine pupils' learning outcomes in problem-solving tasks but is primarily a matter of targeting digital technology to pupils who experience different challenges in their learning. (Mari-Pauliina Vainikainen)

12 In the critical online reading tasks, it was found that the more the pupils' (N≈4000) prior understanding of each topic matched that of scientific knowledge, the better they performed on tasks requiring verification and questioning of reliability. There were no differences in the skills of pupils at different grade levels. It seems, therefore, that critical reading as part of more general critical thinking skills and multiliteracy is still developing at the lower secondary school age and that content-specific knowledge plays an important role in making interpretations. Teaching reliability assessment should therefore be systematically invested in the teaching of all school subjects throughout lower secondary school. (Carita Kiili, Reijo Kupiainen & Annika M Svedholm-Häkkinen)

Critical reading as part of more general critical thinking skills and multiliteracy is still developing at the lower secondary school age and that content-specific knowledge plays an important role in making interpretations. Teaching reliability assessment should therefore be systematically invested in the teaching of all school subjects throughout lower secondary school.

PART 3 - UTILISATION OF DIGITAL TECHNOLOGY DURING LESSONS

13 On average, lower secondary school pupils' ratings of their own interest and effort in lessons in different subjects were quite high. The digital delivery of lessons explained some of the motivation and group dynamics in the lessons and these effects were largely positive. Digital delivery of the lesson increased lesson engagement in mathematics and in mother tongue, and digital delivery of the lesson increased pupils' effort. In contrast, in physics and English, digital delivery of the lesson reduced pupils' engagement in the lesson. Using digital devices and environments as part of the lesson can increase pupil engagement and positive social interaction, and this should be taken into account when planning lessons. (Satu Koivuhovi, Natalija Gustavson & Mari-Pauliina Vainikainen)

Using digital devices and environments as part of the lesson can increase pupil engagement and positive social interaction, and this should be taken into account when planning lessons.

14 Based on lesson observations and interviews, digital devices and environments were mostly used in lessons to refresh knowledge. The use of digital devices and applications to facilitate learning should be critically examined, as pupils themselves often perceive the tasks offered by the school as too easy. Pupils should be offered opportunities for problem solving and creative learning through digital tools rather than surface-level processing of information, as the use of easy and surface-level processing technology sends the wrong message about the potential of digital devices and environments to support learning. Digital interaction skills and personal safety online are topics that pupils feel should be discussed more in schools. (Sanna Oinas & Risto Hotulainen)

Pupils should be offered opportunities for problem solving and creative learning through digital tools rather than surface-level processing of information, as the use of easy and surface-level processing technology sends the wrong message about the potential of digital devices and environments to support learning.

15 In light of the assessment criteria of an internationally developed digital literacy test, just over half of Finnish lower secondary school pupils ranked in the top third in information retrieval skills. However, the test results suggest that there is still considerable room for improvement in pupils' ability to manage, combine, evaluate and create information. It is recommended for teachers to share information with their colleagues on how to teach the different aspects of digital literacy in order to facilitate the design and implementation of digital learning situations. Producers of learning materials should develop a wider range of learning materials to support digital literacy learning. (Risto Hotulainen).

It is recommended for teachers to share information with their colleagues on how to teach the different aspects of digital literacy in order to facilitate the design and implementation of digital learning situations. Producers of learning materials should develop a wider range of learning materials to support digital literacy learning.

References:

Korhonen, T., Salo, L., Laakso, N., Seitamaa, A., Sormunen, K., Kukkonen, M., & Forsström, H. 2022. Finnish teachers as adopters of educational innovation: perceptions of programming as a new part of the curriculum. Computer Science Education, 1–23. Doi: 10.1080/08993408.2022.2095595.

Leino, K., Puhakka, E., Niilo-Rämä, M. 2021. Tieto- ja viestintäteknologia koulujen arjessa. ICILS opettajapaneeli 2020 -tutkimuksen tuloksia. Koulutuksen tutkimuslaitos. ISBN 978-951-39-8913-2.

Mertala, P. Moens, E., & Teräs, M. 2022. Highly cited educational technology journal articles: A descriptive and critical analysis. Learning media & Technology. Doi: 10.1080/17439884.2022.2141253.

Oinas, S. 2022. Tietoinen oppiminen. Palaute osana oppimisen itsesäätelyä. . Teoksessa N. Hienonen, P. Nilivaara, M. Saarnio & M.-P. Vainikainen. Laaja-alainen osaaminen koulussa. Ajattelijana ja oppijana kehittyminen. Gaudeamus.

Opetushallitus. 2014. Perusopetuksen opetussuunnitelman perusteet 2014. https://www.oph.fi/sites/default/files/documents/perusopetuksen_opetussuunnitelman_perusteet_2014.pdf.

Pettersson, F. 2021. Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. Education and Information Technologies, 26, 187–204.

See, B.H., Gorard, S., Lu, B., Dong, L., & Siddiqui, N. (2022) Is technology always helpful?: A critical review of the impact on learning outcomes of education technology in supporting formative assessment in schools, Research Papers in Education, 37:6, 1064-1096.

Vainikainen, M-P., Oinas, S., Koivuhovi, S., Polso, K-M., Leinonen, J., Nazeri, F., Nyman, L., Mergianian, C., Gustavson, N., Lindgren, E., Asikainen, M., Ihantola, P. & Hotulainen, R. 2022. Digitalisaation vaikutus oppimiseen, oppimistilanteisiin ja oppimistuloksiin: DigiVOO-hankkeen väliraportti 2022 Tampereen yliopisto, Helsingin yliopisto.

Vedechkina, M., & Borgonovi, F. 2021. A revies of evidence on the role of digital technology in shaping attention and cognitive control in children. Frontiers in Psychology 12, 611155. Doi: 10.3389/fpsyg.2021.611155.

HELSINGIN YLIOPISTO

Tampereen yliopisto

OPETUS- JA
KULTTUURIMINISTERIÖ