Trends and Issues of Digital Learning in Finland

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Abstract

This chapter presents trends and issues of digital learning (DL) in Finland, particularly those focusing on K–12 education. Finland has been globally recognized for its education system that emphasizes equity, high-quality teaching, and a holistic approach to learning. In general, education is highly valued in Finland and is considered a cornerstone of personal development and vital for overall societal well-being. During the past 20 years, Finland has been investing strongly in the digital infrastructure of society. The Finnish digital infrastructure is among one of the most developed internationally, and provides great opportunities for digital learning and skill development of teachers and students. However, the latest studies have indicated that digital transformation is not occurring in Finland on a large scale yet, as digital technologies are seldom used in K–12 schools for ways that activate thinking and are inquiry-based and collaborative. Finnish students also seem to adopt most of their digital competencies outside of school, which increases inequality due to students' socioeconomic backgrounds, and creates risks for unregulated overdose of the use of digital technologies in their free time. However, recent research has demonstrated positive indications as well, such as more systematic strategic planning and increasing commitment of school communities to digital transformation. A need exists for the training of preservice teachers and the professional development of in-service teachers to ensure that teachers are able to integrate digital technology effectively and in pedagogically meaningful ways into their teaching, and students are able to use digital tools confidently and responsibly for learning.

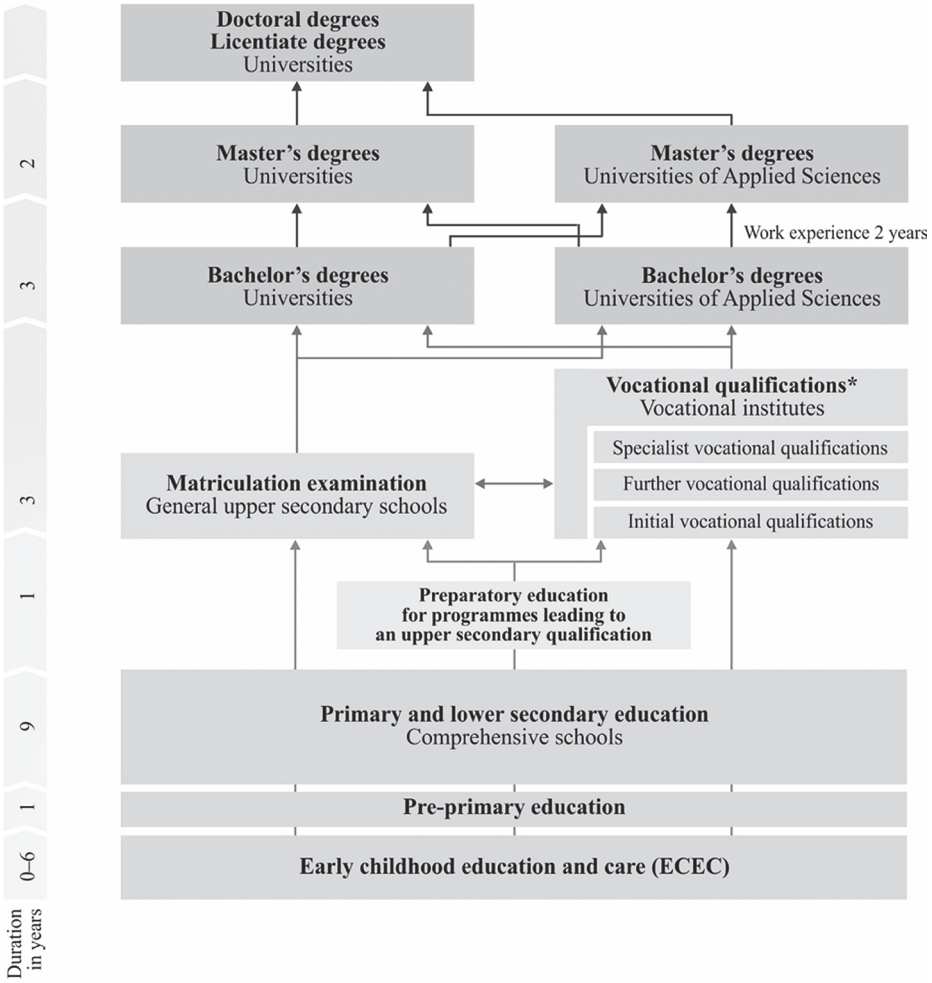
Keywords: digital learning, digital transformation, K–12 education

Introduction

Structure of the schooling system

This chapter presents current trends and issues of digital learning (DL) in Finland by particularly focusing on K–12 education. Education is highly valued in Finland and is considered a crucial aspect in a small country for supporting personal development and overall societal well-being. Finland has been globally recognized for its education system that emphasizes equity, high-quality teaching, and a holistic approach to learning. The Finnish education system is described in Figure 1. It consists of early childhood education and care (ECEC), preprimary education, primary and lower secondary education (K–12), general upper secondary education, vocational education, higher education in university and universities of applied sciences (bachelor's and master's degrees), and adult education. Compulsory education applies for all those who are 6–18 years old. It includes preprimary, basic, and upper secondary education. After nine years of basic education, general upper secondary or vocational upper secondary education and training are offered. In general, upper secondary education leads to the matriculation examination, and vocational education leads to vocational qualification.

Figure 1 Education System in Finland



* Also available as apprenticeship training or by training agreement.

Note. Modified from the materials of the Ministry of Education and Culture.

Digital transformation (DX) and the current stage in K–12 schools

Highly digitalized societies worldwide are witnessing a digital revolution that requires the renewal of human competences in all aspects of life—including educational and working environments (Haddington et al., 2021). The digital revolution, with the renewal of human competencies, may create a digital transformation of societies, including educational systems. Digital transformation of the societies has been acknowledged as a global megatrend and emphasized by several organizations, including the OECD (OECD, 2016), the United Nations in their Sustainable Development Goals (UN, 2020), and also by The Finnish Innovation Fund (Sitra, 2020). The topic of digital transformation has been gaining importance in Finland, and, in recent years, Finland has been investing strongly in digital infrastructure for education, including high-speed internet connectivity, cloud computing, and online learning platforms (Leino et al., 2023). These investments have enabled K–12 schools to adopt digital learning tools and platforms more easily, and helped to ensure access to high-quality education to students, regardless of their location, even in the rural areas of northern and eastern Finland (Tanhua-Piiroinen et al., 2020).

Finland can be considered to be at an advanced stage of digitization, digitalization, and digital transformation. Digitization refers to the process of converting analog information into digital format. In the educational context, this involves converting traditional learning materials, resources, and administrative processes into digital formats. Finland has made significant advances in digitizing educational content, including textbooks, educational materials, and administrative records. Digitalization goes beyond converting analog information to digital. It involves the integration and utilization of digital technologies to improve processes and services. In the realm of education, digitalization includes the use of technology applications, digital tools, and online resources to support teaching, learning, and administrative functions. Finland has embraced digitalization in its education system by incorporating technology applications, interactive learning tools, and digital platforms into classrooms and

administrative tasks. Finland has a long history of using technology in education, and digital learning is a natural extension of this tradition. According to Kaarakainen and Kaarakainen (2018), the history of digitalization in Finnish K–12 schools includes three phases. The first phase occurred during 1998–2004, when the focus of digital development was on creating a well-functioning digital infrastructure, including the creation of internet connectivity and digital learning materials. The second phase occurred during 2005–2010, and it concentrated on evaluating the benefits of using technology for teaching and learning. During this and the previous phases, different ICT-related development and research projects aimed to explore ways of implementing digital technologies in teaching and learning. The third phase occurred during 2010–2018, and it recognized diverse needs and uses of digital technologies for learning. Since 2018, opportunities for digital learning in Finnish K–12 schools have been extended, and teachers' digital-pedagogical skills have been supported, for example, by project funding and initiatives from the Finnish National Agency for Education and the Ministry of Education and Culture. As happened in many countries worldwide, the COVID-19 pandemic accelerated the need for functional digital systems, and necessitated a focus on the topics of students' and teachers' well-being in studying and working in remote and online digital systems.

Digital transformation is a broader concept that encompasses a fundamental shift in the way organizations and institutions operate due to the adoption of digital technologies. It involves rethinking and reshaping workflows, strategies, and organizational culture to leverage the full potential of digital advancements. In the context of education, digital transformation would involve not only the use of technology in classrooms but also a reimagining of pedagogy, assessment methods, and the overall learning experience. While Finland has been progressive in digitization and digitalization, the extent of its digital transformation in education varies across schools and regions.

The Status of Digital Learning

Contexts of digital learning (DL)

Finland is among the most highly digitalized countries, and many of its services are digitalized; thus, the need to provide access to digital services for all citizens is very accurate. Some of the Finnish schools are quite innovative in providing the needed digital skills for their students; however, the current overall state of digital learning in K–12 schools in Finland indicates that some areas need improvement. When, for example, comparing the amount and quality of the use of digital learning to other high infrastructure countries, Finnish schools and teachers generally use digital learning opportunities less than those in many other countries, for example, in EU countries (European Commission, 2019; Fraillon et al., 2020; Smahel et al., 2020). Kaarakainen and Saikkonen (2021) showed that before the COVID-19 pandemic, Finnish teachers used digital devices once a week on average in different ways for different subjects. Kaarakainen and Saikkonen (2021) also pointed out that the most common use of digital technologies was related to information searching and information processing tools, such as word processing. This indicated that the use of digital technologies for activating thinking and engaging learners in inquiry- and problem-based and collaborative learning activities was rare. Thus, opportunities for true digital transformation of Finnish educational systems have not been actualized.

The differences in teachers' use of digital technologies have been explained as being due to individual reasons (e.g., digital skills, competencies, and interests), not to school- or municipal-level factors, such as infrastructure (Kaarakainen & Saikkonen, 2021). Finnish teachers are quite autonomous, and the development of digital competences and skills has often been left up to the teacher's own interest and orientation, in which case the development seems to be slow and has created some differentiation of K–12 teachers' use of tech-

nology in teaching. For example, Tanhua-Piiroinen et al. (2020), Kaarakainen et al. (2018), and Kaarakainen and Saikkonen (2021) have shown that male teachers use digital technology more often than female teachers in their teaching, and young teachers use digital technologies in teaching more often than their older colleagues. In addition, the International Computer and Information Literacy Study (ICILS), which is a comparative study of OECD countries, found that male teachers' beliefs in their digital ability were stronger than those of female teachers (Fraillon et al., 2019; Gebhardt et al., 2019). In terms of age, teachers under the age of 40 have been found to believe in their own digital skills more than older teachers (Fraillon et al., 2019; Leino et al., 2019).

While digital technologies have the potential to provide access to high-quality education, concerns about equity have been raised. Due to the differentiation in teachers' use of digital technologies, concerns about some students being left behind regarding their digital skills and competence development remain. The Finnish school system has traditionally been seen as a place to provide equal opportunities for all. As digital teaching is differentiated, there is a risk that, for example, students from disadvantaged backgrounds may not have access to the technology and digital infrastructure needed to participate fully in digital learning as well as other leisure-time digital activities that are vital for adolescents' digital culture. Finland has been working to address this issue by providing funding for digital infrastructure in K–12 schools and devices and connectivity to students who need them. The number of devices, software, and internet connectivity is no longer a high barrier to digital learning in Finland.

K–12 students' digital competences have also been explored, and studies show that development expected during the last few years has not occurred (Kaarakainen et al., 2017; Tanhua-Piiroinen et al., 2019). Although Finnish students use digital devices (e.g., computers and smartphones) actively in their free time, students report that they are learning necessary digital skills outside of school (Hotulainen & Oinas, 2022). Differences in students' digital compe-

tences are mostly explained by hobbies or free time use (Koivuhovi et al., 2022). Mere use of smartphones or computers does not explain and enhance digital literacy or competence; that is, it does not enhance one's understanding of the purpose of digital technologies. Slight gender differences have been observed in digital competences, where girls outperformed boys in some recent studies in computational thinking (Leino et al., 2019) and also performed better in digital communication-related tasks, whereas earlier studies indicated that boys performed better in computational thinking and technical tasks (Kaarakainen et al., 2017). Teachers' digital competence has slightly improved in recent years (Tanhua-Piiroinen et al., 2019). However, in Finnish schools, ICT is mostly used by teachers for their own purposes, for example, to communicate with children's guardians instead of using it for learning purposes and activating their students' thinking (Leino et al., 2019; Taajamo & Puhakka, 2019).

In summary, digital learning is a growing trend in Finland, which is driven by a desire to provide high-quality education that is accessible to all students and is versatile in pedagogy, particularly enhancing the active role of learners as well as digital skills and competence development. Two polarized extremes can be identified in the societal debate: on the one hand, the importance of digital skills and capabilities is emphasized, while on the other hand, concerns exist about the digital skills of teachers to implement digital learning in their classrooms in pedagogically sound ways to activate thinking and support inquiry-based, problem-oriented, and collaborative learning. While challenges to be addressed—including concerns about equity, the use of digital technologies, and the need for teacher training—exist, digital learning is seen as an important tool for developing educational opportunities in Finland.

DL policies, projects/programs, strategies and R&D

The first initiatives in using digital technology in education were already implemented in the 1980s (Saarikoski, 2006), indicating that the general inter-

est in policy and practice on the topic is not new in Finland (Olofsson et al., 2021). In the 2000s, the first international evaluations of using digital technology were favorable in terms of Finnish educational policy (OECD, 2004), but the later evaluations were less positive (OECD, 2015). Since the 2010s, the educational policy around digital learning started to be more active (Olofsson et al., 2021). However, it started with the digitalization of matriculation exams at general upper secondary schools instead of developing digital learning opportunities in K–12 education. Most of the surveys on digital learning in the context of Finnish K–12 education have been conducted at the lower secondary level of comprehensive school, and much less at the level of primary schools. However, many of the R&D initiatives that have been taken support primary-level education. For example, the Innokas Network (https://www.innokas.fi/en/) encourages schools to arrange their own development activities that support the learning of so-called 21st-century skills (Korhonen et al., 2022).

According to Olofsson et al. (2021), digital competence is not directly mentioned in Finnish policy strategies. However, ICT skills and competences are referred to in the Finnish national K–12 curriculum (Finnish National Agency for Education, 2014) that was adopted in 2016. It highlights ICT skills and competences as a part of transversal competences. ICT competence in the Finnish K–12 curriculum refers to following four digital learning areas: (1) understanding the use and principles of ICT for making products; (2) using ICT in responsible, safe, and ergonomic ways; (3) using ICT for information searching, inquiry, and creativity; and (4) using ICT in interaction and networking. The flagship projects funded by the Ministry of Education and Culture can be named as an example of projects that have focused on the development of teacher education, including teachers' ICT skills and competencies to support and enhance digital learning opportunities in schools and teacher education (Lavonen et al., 2020; Lavonen et al., 2021). Another example is the New Literacy Skills (https://uudetlukutaidot.fi)—a development program

that emphasizes the learner's right to digital competence and digital literacy. Among other things, the program highlights self-expression and participation, active and responsible agency, and the development of versatile critical thinking skills—all of which are highly needed in an increasingly digitalized society.

Finnish teachers and schools have great autonomy to conduct teaching by following the guidelines of the national curriculum. Therefore, the use of digital technologies varies greatly in Finnish schools and among Finnish teachers (Ahtiainen et al., 2021; Leino et al., 2021; Vainikainen et al., 2022). In addition, the assessment of the implementation of digital technologies to support students' digital skill development has proven to be challenging (Ouakrim-Soivio, 2022). For example, computational thinking and programming are a part of the ICT skills mentioned in the curriculum; however, teachers are often unsure about when and how much computational thinking and programming should be taught to their students in K–12 classrooms (Fagerlund et al., 2022). Many researchers have highlighted that computational thinking needs to be learned to understand programming to ensure that it is creatively applied in solving problems in different fields and everyday life situations (Michaelson, 2015). Computational thinking has been highlighted as an essential basic skill, along with writing, reading, and arithmetic skills. Despite its high relevance, the current practices are just being formulated in basic education and teacher education pointing to how to implement computational thinking and programming in teaching, and the skills and competencies required to be enhanced during different schooling years.

DL implementation in K–12 schools

Finnish K-12 schools have been implementing various technology applications to enhance learning and teaching. The frequency of technology applications usage in Finnish K-12 classrooms varies depending on factors such as teacher preferences, available resources, and the age group of students. While

technology is integrated into classrooms, it is not used excessively or as a substitute for traditional teaching methods. The technology landscape is constantly evolving, but some of the common technology applications used in Finnish K-12 schools include, for example, the following.

Learning Management Systems (LMS): LMS platforms are used regularly to manage homework, assignments, and assessments. They also facilitate communication between teachers, students, and parents, as well as track student progress. **Educational Apps and Software**: The usage of educational apps and software varies depending on the subject and the teacher's approach. Some teachers integrate educational apps into their lessons regularly, while others use them more sparingly or for specific learning objectives. These applications could include language learning apps, math practice programs, science simulations, etc. **Digital Content and E-books**: While digital content and e-books are available in some schools, they are not the exclusive means of learning. Print materials still play a significant role in many classrooms. Schools may adopt digital textbooks and other educational materials to provide students with more interactive and engaging learning resources. **Interactive Whiteboards and Projectors**: Interactive whiteboards and projectors are used in classrooms for presentations and interactive activities, but they are not the primary method of instruction in all cases. Interactive whiteboards and projectors can be used to make lessons more interactive and visually engaging. They allow teachers to display multimedia content and collaborate with students in real time. **Online Collaboration Tools**: Finnish K-12 schools may use online collaboration platforms to facilitate group work, discussions, and project-based learning, enabling students to work together both in and outside the classroom. Online collaboration tools are used as needed for group projects and discussions, but not necessarily in every class session. **Coding and Programming Tools**: Some schools have been introducing coding and programming tools to foster digital literacy and computational thinking among students. Coding and programming tools have been typically introduced in

later grades, and their usage might be more frequent in specialized technology or computer science classes. **Virtual Reality (VR) and Augmented Reality (AR)**: VR and AR technologies have been less commonly used. They might be implemented as part of specific educational projects or initiatives. VR and AR technologies can be used to create immersive learning experiences, allowing students to explore historical sites, scientific concepts, and more. **Online Assessment Tools**: Digital assessment tools can streamline the evaluation process and provide teachers with insights into student performance. Online assessment tools have been used for certain assessments, but traditional assessment methods (e.g., written exams) are still prevalent. **Video Conferencing Tools**: Video conferencing tools have gained more prominence during exceptional circumstances, such as the COVID-19 pandemic, when remote teaching and learning were necessary.

The specific applications used can vary between schools and regions based on teachers' individual preferences, resources, and educational philosophies. As such, digital technology usage is not standardized and can vary significantly from one classroom to another. The frequency of technology use in Finnish classrooms might continue to evolve over time based on changes in technology trends and educational philosophies.

The impact of COVID-19 on DL

The COVID-19 pandemic and subsequent emergency remote teaching can be viewed as a moment of global testing in terms of the digital readiness of schools. The pandemic quickly and extensively changed the digital competence needs of both teachers and learners, and highlighted society's level of digital readiness. The previously described national actions promoting the digitization of education contributed to preparing the education system and its actors—teachers, pupils, and students—in different education sectors to face the changing state of digital learning in the form of large-scale online education. This fundamental and sudden transition brought valuable information about

the well-being and coping of different actors, such as principals (Ahtiainen et al., 2022), teachers (Dindar et al., 2021; Niemi & Kousa, 2020), and students (Orbach et al., 2023) and their guardians (Sorkkila et al., 2023), the challenges they experienced and their readiness for change. Now we know that some individuals were more ready for change than others: the period brought to the forefront the inequality of digital skills and opportunities between individuals, schools, and regions (Lavonen & Salmela-Aro, 2022) and a learning gap that followed the pandemic period (Donnelly & Patrinos, 2022; Engzell et al., 2021; Lerkkanen et al., 2023).

The teaching methods that were used during the pandemic were also explored. K–12 students reported that the number of tasks was greater than before, the support provided by the teacher was less available, and the online learning environments were difficult to use (Ahtiainen et al., 2021; Kankaanranta & Kantola, 2020). In schools, the situation of distance education was complicated by, among other things, their different starting points and differences in the digital skills of teachers and students. Some schools and educational institutions had an established digital teaching culture in which various learning platforms and digital applications had already been used extensively, and both students and teachers had good digital skills and capabilities, and they were comfortable engaging in digital activities. Instead, some of the educational institutions were in a situation in which distance education needs surprised all actors. COVID-19 remote education also emphasized students' individuality in learning skills, such as self-direction and self-regulation of learning. Along with the needs and opportunities for social interaction, students' lack of self-regulated learning skills turned out to be key challenges during the pandemic, putting students in different situations in terms of distance learning capabilities and realized distance education (Hadwin et al., 2022; Näykki et al., 2023). The pandemic has shown that when the means of teaching needs quick modification, the importance of different individual skills is emphasized. Thus, the potential unequal development of digital competence and digital crisis preparedness

poses challenges to the equality of learners.

A somewhat surprising result is that the COVID-19 period reduced the number of teachers participating in continuing education (Leino et al., 2023). During the COVID-19 pandemic, teachers were offered continuing education and professional development courses, and the courses switched to web-mediated for some time. Web-mediated courses can promote accessibility and make it easier for teachers to schedule their personal timetables; however, they may also decrease teachers' interest and commitment to participate. According to the study by Leino et al. (2023), the decrease in teachers' participation was the highest for the courses that taught about certain applications and programs (e.g., word processing or spreadsheet programs). The least amount of participation was in courses that dealt with the educational use of ICT for students who needed special or individual support. This content is perhaps thought of as the activities of a special education teacher, even though every teacher should be able to provide general-level support to their students, if needed, regardless of whether they are engaged in on-site or distance education. When exploring the most popular ways to develop digital skills, Leino et al. (2023) highlighted the informal peer support organized in teachers' own schools. This has been found to be an important forum for sharing ideas and providing collegial support during various challenges. Of the more formal continuing education forms, participation in online discussion groups examining teaching and learning increased the most. Participation in such online discussions increased the most in northern Finland, which was statistically significantly different from other regions (Leino et al., 2023).

Digital learning infrastructure

To develop digital learning opportunities and competences, the digital learning infrastructure needs to be well developed and functional. In this chapter, DL infrastructure is not only defined as a general technological infrastructure but also includes other variables, such as leadership and budget, course design and

delivery, student success for digital learning and needs for teachers' professional development.

DL infrastructure in K–12 schools

The digital learning infrastructure of Finnish K–12 schools has been continuously developed. In general, schools have enough digital devices suitable for multiple uses, and the number of devices has been increasing systematically (Tanhua-Piiroinen et al., 2020). In addition, high-speed connectivity is no longer an often-experienced challenge. These issues will be explained in more detail in the next section.

Despite technical advancements, the use of digital infrastructure in Finland has been modest, for example, in international comparison studies (et al., Leino et al., 2019) the use of digital infrastructure has been highlighted in limited ways, without any encouragement for students' active agency and as a support for thinking-activating and problem-solving tasks (European Commission, 2013; Fraillon et al., 2020; Smahel et al., 2020; Tanhua-Piiroinen et al., 2020). According to Tanhua-Piiroinen et al. (2020), teachers also prefer ready-made learning materials offered by major publishers, while simultaneously criticizing their lack of interactivity and expensive prices. The use of digital learning materials and platforms, mobile applications, digital assessment tools, and networking services has slightly increased during the last few years.

Digital learning infrastructure, in terms of leadership and budget, is an important but challenging question that needs to be thoroughly answered. In the Finnish education system, schools and their leaders are highly autonomous. This means that no central information has been collected about the ways of leading the schools' digital transformation or the budget to be used for the development of digital learning infrastructure and updating devices and program licenses. However, some positive indications for change during 2017 and 2019 have been observed. According to Tanhua-Piiroinen et al. (2020), school prin-

cipals reported learning more systematically than the earlier municipal-level strategy in planning digital transformation. In addition, the importance of the whole school community and changes in operational school culture have been emphasized. During 2017 and 2019, the commitment of the working community toward digital transformation developed positively. In the process of change, principals perceive their role as enablers; they are responsible for resource allocation and encouragement for change. Digital technologies not only transform a learning organization but also offer high potential for schools. We argue that leading digital transformation in a learning organization requires different leadership approaches and organizational structures to allow more autonomous, team-based efforts for digital innovation across education ecosystems (Kowch, 2018). A new type of thinking is needed to truly adopt new kinds of processes. Innovation in education systems means much more than invention or technology adoption alone.

Key statistics and practical examples

Tanhua-Piiroinen et al. (2020) explored Finnish K–12 schools' current digital learning infrastructure. Their study indicated that almost all Finnish K–12 schools have well-functioning wireless network connections. In terms of teachers' digital devices, Tanhua-Piiroinen et al. (2020) showed that almost 57% of the teachers had a laptop for their personal use, and slightly more than one-half (53%) had received a tablet for their own use. In contrast, 13% of schools' teachers did not have any personal devices. Based on the school principals' answers, the number of tablet devices in proportion to the number of students was 0:25 on average, which meant that one device was available per four students (1:4). Of the schools, 16% had an equipment ratio of one device per two students. In only 2% of the schools did each student have his or her own device (1:1). When the number of laptop computers was compared to the proportion of students, the availability of one laptop per seven students (1:7) was evident. Of the schools, 3% had one laptop per two students (1:2). The number of desktop computers in proportion to the number of students was on

average 0.08, or 1:12.5. During school visits, only one school had a separate computer classroom left, which was no longer used much. A tablet, either alone or with a computer, seems to be the most commonly available and used device, at least in the lower-grade levels of primary school.

Large school-specific and teacher-specific differences were noted in the use of students' own smart devices during school days. In some schools, students' own devices were a self-evident part of lessons, especially in tasks related to information retrieval, and efforts were made to promote the use of students' own devices, for example, by joint Kahoot! quizzes and involving students in the content production of the school's social media channels. In some schools, the use of one's own devices was completely prohibited during the school day. In one of the teachers' interviews, it became apparent that teachers could also have different interpretations of such a rule on students' access to mobile devices. That is, teachers can sometimes decide to use their own devices in their own lessons, even though their use is otherwise prohibited during the school day. This is an example of the teacher's autonomy, which can be seen here as well.

According to the 2018 ICILS survey (Leino et al., 2019), more than 90% of Finnish lower secondary schools had internet connections, wireless LANs, and central platforms (e.g., Pedanet, Wilma, or similar) and applications (e.g., word processing and spreadsheet programs). Devices and programs, which were fewer, were just becoming common or used in a specific subject (such as data collection and tracking devices and programs). Of the different types of software, the number of multiuser games with graphics and exploratory learning tasks that became available to teachers and students had increased the most. They were now in more than 60% of schools. However, the possibility for teachers and students to use the drawing and graphics programs offered by the school had weakened statistically significantly, although they were still available in 86% of the schools. Of the various devices, 3D printers and programmable robots increased significantly. In 2018, robots were found in al-

most two out of three schools, and in 2020, robots were already found in three out of four schools. In 2018, 3D printers were in every third school; however, in 2020, 3D printers were in every second school.

In 2018, the least equipped school had 25 students per computer, while the average for all schools was 3.2 students per computer. At the end of 2020, the least equipped school had eight students per computer, and the average of all schools had 2.4 students per computer. In 2020, approximately 30% of schools had acquired laptops for at least three out of four students to use at home or school. In 2018, the corresponding figure was only 11%. No statistically significant differences were observed in the number of computers used by students in schools between regions and municipalities or cities of different sizes. It is noteworthy that one-quarter of schools did not offer every teacher a laptop yet. In this regard, too, the situation improved, as in 2018, more than 40% of such schools had provided a laptop for their teachers.. The starting point for schools to actively use information and communication technology as part of teaching thus improved from the point of view of equipment availability. However, at the level of individual schools, clear differences were observed in opportunities for both students and teachers to use computers. Differences were also noted between schools, and even a single school had different solutions for the location and distribution of computers available to students at the same time. The most common computers in schools were, for example, laptops kept in carts that could be transported from one class to another (almost three out of four schools). About half of the schools had computers in computer classes. In other words, many schools had computers both in the computer classroom and in delivery carts. Only one-quarter of the schools reported that they had computers in most (over 80%) classrooms. Compared to 2018, the use of all aforementioned solutions in schools had decreased, and in more and more schools (a change from 29% to 41%), at least some of the students carried computers with them to class.

Features of digital learning

We selected the following four features of digital learning in Finland. These features were obtained from comparisons with K–12 schools in other equivalent countries and those between K–12 schools and colleges in Finland.

The first feature: According to an international comparative study by ICILS (Leino et al., 2019), one-third of Finnish youth have an excellent level of multiliteracy skills; however, about one-quarter of the students' skills are weak. Furthermore, Finnish students' computational thinking skills are among the top three examined countries, and Finnish girls have better skill levels than boys.

The second feature: The ICILS study (Leino et al., 2019) indicated some regional differences in skill levels (for the benefit of southern and western Finland), but a more in-depth evaluation showed that these differences were explained by the socioeconomic differences of the families. In other words, parents' or guardians' education and occupation, and the number of books at home had a clear effect on the students' skill levels. Young people with immigrant backgrounds had a clearly lower level of measured skills. Students who had been using computers for a longer time received better outcomes in their ICT tests than those who had less experience.

The third feature: What was particularly surprising in the ICILS study (Leino et al., 2019) was that only one-tenth of young Finnish individuals used ICT devices daily at school. Finnish youth used ICT devices as a support for learning less than the youth in other countries. The study also indicated that Finnish youth have learned their ICT skills mostly from outside school. Naturally, informal learning in terms of ICT skills is important, but the problem relies on when the use is not pedagogically planned and does not necessarily support skills for self-regulation of the way ICT is used.

The fourth feature: According to our literature review, a need for more systematic research on K–12 schools' digital learning has been felt to explore in more detail the current situation and future vision of digital learning in Finland. We argue that a need exists for a more systematic vision and a research agenda to examine the skills of younger students, especially at the primary level in K–12 schools. We should explore teachers' and students' beliefs about ICT skills, their actual skills, and how they view the meaning of ICT skills in a digitalized society. We should also aim for observational and classroom ethnographic research to examine how and for what purposes ICT is used during school days.

Trends and Issues in Digital Learning

Trends in digital learning

Trend 1: An emerging digital revolution

We are globally witnessing an emerging digital revolution that can be compared to the time of internet introduction and rapid development. During the past 20 years, digital technologies, such as the internet and smartphones, have transformed our working and studying environments and significantly provided new possibilities. The speed of change will be even greater over the next few years. The citizens of the world are already witnessing how, for example, artificial intelligence (AI), the internet of things (IoT), virtual/augmented/mixed reality (VR/AR/XR), and robotics are developing quickly and will soon become more ubiquitous and invisible parts of our everyday life. Such development brings not only advantages but also concerns. *New technologies speed up some routine processes and provide automation and support; however, at the same time, change needs control and ethical conciseness*. In Finnish K–12

education, such change is occurring, and some of the more advanced schools have already been investing in the infrastructure of modern technologies and exploring ways to use technologies, for example, those of VR/AR/XR. However, scaling up the use of emerging technologies is still in its early years.

Trend 2: The growing use of data, development of algorithms, increased computing capacity and interconnectedness

The next big wave of digitalization is already underway. Particularly because of the development of AI, technologies are not only helping people do things faster but are also profoundly changing the ways in which things are done (Sitra, 2016). As AI-powered applications become more common, they are expected to bring about significant changes in everyday life (Sitra, 2020). The growing use of data, development of algorithms, and increased computing capacity and interconnectedness are suspected to lead to increased use of voice-controlled machines, speech and facial recognition, traffic automation, conversational robots, and personalized recommendation systems (Sitra, 2020). *Consequently, a growing need to discuss the impact of technology and develop new competences to understand technology, and its ethical use (Sitra, 2020) also exists*. In Finnish K–12 schools, AI-powered applications are not yet in their peak development phase, but Finland is investing in R&D projects to search for ways of harnessing AI's opportunities for educational purposes. For example, the Strategic Research Council is funding the research project, Generation-AI, that aims to engage AI developers, schools, government, business, and NGOs to define technology in the AI era, that is, in terms of not only its mechanisms, opportunities, and dynamics but also its weaknesses, biases, and risks.

Trend 3: The importance of digital, technological, and information literacy

One fundamental and very specific working-life competence that is currently

highlighted concerns literacies. The importance of digital, technological, and information literacies is only increasing. Possessing adequate and appropriate literacy skills means being able to critically review information and acknowledge that it is extensively available everywhere. Data literacy corresponds to this type of new competency, meaning that it is always more important for individuals to be able to understand how information is transmitted to data and how data are transformed, stored, and used in a variety of causes. Digital services and hardware collect and manage large amounts of personal data in our everyday lives (OECD, 2016, p. 15; Sitra, 2020). *While the data enable AI-based solutions with great positive potential, people have difficulty understanding what data are being collected and siloed. Furthermore, recent scandals about data misuse or leaks highlight issues of ethics and data management*. In Finnish educational discussions, data literacy and algorithmic awareness are still evolving topics. These have been recognized as important skills in a modern data-driven society; however, K–12 schools have not yet been able to actively take hold of them.

Trend 4: Learning analytics for collecting evidence of learning progression and for providing feedback channels for learners and teachers

Digital communication is also transforming and is expected to include more multimodal and intermedial materials that will combine seamless talk, writing, and various types of visual information. It can be expected that, all the time, more realistic digital spaces and places for interaction will become prevalent. For example, the development of mixed-reality environments, where realistic 3D images of places, objects, and people can be projected, will provide new possibilities for interactive learning and working. In addition, interaction opportunities with artificial and intelligent assistants will be dramatically improved in the coming years. Data processing opportunities, that is, the development of technologies and increasing computing capacity are expected

to make advances in how, for example, learning analytics (LA) can be used in learning situations to collect evidence of learning progression and provide feedback channels for learners and teachers. *This digital trend calls for a focus on the reliability and safety of digital communication (OECD, 2016, p. 14), including ideas about the ethical use of LA in learning*. Finnish K–12 schools are currently implementing some of the LA tools in their teaching. One example is the ViLLE/Eduten platform (Laakso et al., 2018) that collects data on learning and provides teachers with immediate feedback on children's performance and progress, and provides policymakers with information at the group, area, and national levels. The platform uses AI-based methods (machine learning, data mining, neural networks) to capture variability and personalized learning in different subpopulations and to support learners (prescriptive LA, natural language-based intelligent tutoring).

Trend 5: Supporting human learners' unique skills of creative and flexible thinking

In general, digital revolution is affecting the future needs of working life. For example, the McKinsey Global Institute (2017) has identified the following four main skills: technical, cognitive, creative, and interpersonal skills that will account for half of the work activities by 2030. Thus, these skills should also be visible in the current school systems, highlighting social (negotiation and collaboration skills), technical (programming, technology design and maintenance skills), problem-solving (adaptive thinking and design mindset), and process skills (resource management and transdisciplinary skills). What is highlighted here, during the high speed of the digital revolution, is to remember that human learners have unique skills as compared to, for example, AI-based solutions. Learning scientists (for example, Järvelä et al., 2023, p. 1) have pointed out that "human learners are unique in using creative and flexible thinking, expressing and interpreting effects, as well as connecting thinking and action to long-term aims, values, and purposes." Järvelä et al. (2022) also

claimed that it is important to not solely rely on technological advancements but to strengthen human capabilities and support learners to adapt to new situations and tasks; collaborate productively and proficiently; develop socioemotional skills; and have the ability to take the initiative, set goals, and monitor themselves and others in learning. It remains vital to ensure that current and future teachers have the resources and competencies to support their students' above-described skill development. *These skills and competencies will be the key to promoting the resilience and adaptability of individuals and nations (OECD, 2019), particularly during the different crises that will potentially affect the way we go on in our daily lives*.

Issues in digital learning

Issue 1: Digital technology is rarely used in K–12 schools for activating thinking or inquiry-oriented and collaborative ways

Even though the Finnish digital infrastructure is well developed and provides great opportunities for digital learning and skill development, the studies indicate that digital technology is rarely used in K–12 schools for activating thinking or inquiry-oriented and collaborative ways (Leino et al., 2019; Vainikainen et al., 2022). There have been increasing societal and educational policy-level discussions in Finland highlighting that the challenge of education should no longer be about information delivery. What should be aimed at is to create learning environments that use and combine different levels of affordances, such as social and technological affordances, to engage and inspire individuals' and groups' learning (Erstad et al., 2021). Research on technology-enhanced learning and teaching has been active in Finland (e.g., Järvelä et al., 2001; Lehtinen et al., 2001; Näykki et al., 2019, 2022). However, the implications of these and other international studies could be better used for the further development of digitalization in K–12 schools, and also scaled up among broader networks of schools. The 21st century skills, for example, those for learning to learn and collaboratively solve problems in the digital realm, and

those for regulating one's own learning, have been discussed in Finland for some time; however, a challenge remains regarding how to support the development of these skills in practice as a part of everyday learning and teaching practices of digitalized classrooms. Learning scientists have emphasized that learning and working in the 21st century requires high-level learning strategies in individual and collaborative learning settings in addition to digital competences.

Issue 2: Finnish students adopt most of their ICT skills outside of school

It also seems that Finnish students adopt most of their ICT skills outside of school (Hietajärvi et al., 2020), which increases inequality due to students' socioeconomic backgrounds (Leino et al., 2019) and creates risks for an unregulated overdose of the use of digital technologies in their free time (i.e., social media and video games) (Tang et al., 2022). One line of discussion is also the worries of excessive digitalization of adolescents' informal environments with its harmful effects on well-being. Especially, in a public discussion, this was highlighted as one of the greatest concerns regarding the development of digitalization. For example, the discussion lately gained momentum and demands arose for legislation to control the use of mobile phones during school days. Naturally, the well-being of children and young people should be the country's top priority. However, problems related to their well-being may even increase if the schools and teachers within those schools do not support the pedagogically meaningful ways of implementing digital devices in learning, if the children and young people are not supported to learn ways to regulate their own use of digital devices and applications. We argue that only controlling may not be the best solution for finding long-lasting solutions.

Issue 3: A large variation has been found in teachers' skills and willingness to implement digital learning

Current studies have indicated that a large variation has been found in teachers' skills and willingness to implement digital learning in teaching in Finland (Leino et al., 2019; Tanhua-Piiroinen et al., 2020). Therefore, a need exists for training pre-service teachers and the professional development of in-service teachers to ensure that teachers can integrate digital technology effectively and in pedagogically meaningful ways into their teaching, and that students are able to use digital tools confidently and responsibly. One of the support actions is to focus on pre- and in-service teacher education in which digital materials and new learning environments can be used and facilitated through digital-pedagogical training (Näykki et al., 2019). Every Finnish teacher should be offered possibilities for digital skill development and told about good practices. They should learn from and with their colleagues and peers. It is also important to develop evidence-based ideas for digitalization in schools by encouraging and supporting researchers to explore the actual use of digital tools in teaching and learning. In general, a strong consensus has been reached that initial teacher education institutions play an important role in preparing pre-service teachers to take advantage of digital technologies in their future profession (Häkkinen et al., 2017).

Issue 4: Teachers' pedagogical autonomy should not overshadow students' rights to acquire the necessary digital skills

One issue to be concerned with is whether the focus of digitalization is only on adding new digital devices and digital learning materials to the teaching practice. This means that digital devices would be the driver of digital transformation, whereas we argue that pedagogy and the need for supporting learning and interaction should be the drivers of digital change. Teachers' pedagogical autonomy often comes up in discussions about the use of digital tools and devices (Tanhua-Piiroinen et al., 2020). It remains important that, based on their

pedagogical skills, teachers should be able to assess and decide which teaching methods are best suited to the respective teaching content and goals, but the student's right to acquire the necessary digital skills during basic education should not be overshadowed by this. In terms of students' equal accumulation of digital skills, it is important that their achievement does not depend on the enthusiasm of individual teachers. In Finland, no criteria or minimum requirements have been defined for teachers' digital competence, unlike in several other European countries (see European Commission/EACEA/Eurydice 2019 p. 47). In such a scenario, the following question arises: Would there be a need for a national definition of the digital competences of teachers in Finland as well?

Issue 5: The lack of algorithmic awareness can negatively affect the possibilities for societal participation

Equal access to information has increased, which increasingly points to the importance of critical reading. Quickly and unexpectedly, for example, at the end of 2022, we were in a situation in which teachers at all school levels and worldwide had to consider their attitudes toward AI applications when the ChatGPT application based on the language model developed by the OpenAI research center became available to everyone. A widely shared point of view is that, for example, the importance of AI and machine learning should be understood as a permanent part of society, and its responsible present and future use is an essential part of study and working-life skills (Kahila et al., 2023; Vartiainen et al., 2021). Understanding how algorithms and data-based machine learning models guide our operations plays a particularly important role in the responsible use of online environments. The lack of algorithm awareness can affect the possibilities of participation and influence at the societal level and, for example, strengthen existing views by creating echo chambers or filter bubbles, where individuals unknowingly reinforce, for example, political or commercial messages (Gran et al., 2021). Better awareness of the

operation of algorithms and AI creates a basis for active agency and provides tools for understanding the world around us (Gran et al., 2021; Vartiainen et al., 2021).

Issue 6: There is a clear need to guide all teachers in integrating computational thinking in their teaching

Schools play a key role in promoting algorithmic awareness and computational thinking (CT). However, the integration of CT through a problem-solving approach is still emerging in Finnish schools, and exposure to CT varies greatly both among teachers and students (Leino et al., 2019). Fagerlund et al. (2022) investigated Finnish teachers' and students' programming motivation, as well as their role in teaching and learning CT. The results indicated that Finnish teachers do not have a strong intrinsic motivation for programming, although they consider it a timely and important topic. Teachers with prior experience, such as STEAM teachers and male teachers, had higher programming motivation. Students with prior programming experience were more motivated on average. In addition to supporting the motivational aspects of teaching and learning CT, teachers' skills (Kong et al., 2020; Mäkitalo et al., 2019) and the quality of instruction and learning activities (Sun et al., 2022) need to be considered in promoting CT. There is a clear need to guide all teachers in integrating CT into teaching. Due to the autonomy of Finnish teachers, it is especially important to promote their intrinsic programming motivation (Fagerlund et al., 2022).

Conclusion

This chapter has identified and described the current trends and issues of digital learning (DL) in K–12 education in Finland. Countries across the globe are witnessing a rapid digital revolution that can be partly compared to internet development. The digital revolution is greatly due to the data processing power of AI and LA, which are currently transforming the landscape of studying and working (Cukurova et al., 2022; Järvelä et al., 2020; Marzouk et al., 2016). Technologies are developing quickly and will always be a more ubiquitous and invisible part of everyday life. At the same time, teachers and students need digital and ethical skills for implementing digital tools in teaching and learning processes. A need exists for the training of pre-service teachers and the professional development of in-service teachers to ensure that teachers can integrate digital technology effectively and in pedagogically meaningful ways into their teaching, and students are able to use digital tools confidently and responsibly for learning.

Finland has been investing strongly in digital infrastructure, and the Finnish digital infrastructure is among the most developed internationally. The latest studies indicate both negative and positive signals of digital transformation in Finnish K–12 schools. On a large scale, Finnish education and schools are not yet close to improved digital systems. This is because digital technologies are only occasionally used in K–12 schools for activating thinking and for inquiry-driven and collaborative ways. This indicates that the role of digital technologies is still seen as part of routine work, such as information searching and delivery. Learning approaches to activate thinking and those based on inquiry and collaboration have been shown to support highly important learning and group working skills (Dillenbourg, 1999; Jeong & Hmelo-Silver, 2016; Kuhn, 2015; Rochelle & Teasley, 1995). Many of the previous studies have highlighted a different set of skills, and all of these have a shared idea of broad skills that are not only vital for future working life but are also highlighted as

learning and life skills (Binkley et al., 2012; Griffin et al., 2012). For example, by following the identified skills of the McKinsey Global Institute (2017), namely technical, cognitive, creative, and interpersonal skills, it can be argued that these skills should be visible and a central part of current K–12 education.

Finnish K–12 education is still in a transition phase. There is increasing interest, national investments, and lively public discussion on developing digital learning in Finland. However, technology is most usually seen as one tool, among many others. Teachers and principals usually experience digital resources in a way such as textbooks, pens, or other learning materials (Tanhua-Piiroinen et al., 2020). In other words, technology is seen as an everyday tool but not as a cognitive tool to promote thinking (Kim & Reeves, 2007; Kirschner & Erkens, 2006; Pea, 1993). One example of this is the role of computational thinking (CT) in teaching and learning, which is mostly interpreted as a programming or coding skill. According to Fagerlund et al. (2022), we should understand CT more broadly as computational problem solving or as a type of multiliteracy. In this way, students can also examine the practical, political, and ethical dimensions of the computational world around us (Høholt et al., 2021).

Learning scientists have pointed out that human learners are unique in the ways they use creative and flexible thinking, expressions, and interpretations of their own and other's affective reactions, as well as connecting thinking and action to long-term aims, values, and purposes (Järvelä et al., 2023). Thus, school systems should do better not only in harnessing these unique human learning characteristics as a service for learning and well-being, but also for future digital learning developments. It is vital to strengthen human learning capabilities (Hadwin et al., 2018; Järvelä et al., 2022) to adapt to new situations and tasks, develop socioemotional skills in encountering different kinds of challenges, and take initiatives and monitor themselves and others in learning.

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