Trends and Issues of Digital Learning in Estonia

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Abstract

Estonia is a country with a high level of digital readiness and good student achievement in international comparisons. This increases the responsibility of Estonian educational technology researchers to study the use of digital technologies and to suggest directions for improvements, as the Estonian case could be a valuable example worldwide. In this chapter, the authors aim to provide an overview of the Estonian education system and strategic directions for empowering teachers and students in schools with meaningful digital learning and teaching approaches. The Framework for the Digital Competence for Learning and Teaching developed by the authors highlights the need for transformative digital competence in addition to generic and contextual competences. This highest level of digital competence is necessary to advance from the Digitization of education to the Digital Transformation stage. Currently, the results of the DigiEfekt study show that Estonian teachers focus mainly on the constructive use of digital technologies and do not usually provide students with interactive assignments that would foster collaboration. The study also reveals that technology tends to be used as a substitute for traditional learning processes, that is, those not involving technology, or, less often, for the augmentation of learning. Thus, modification and redefinition of the whole learning process and learning goals does not really seem to be the case in Estonian schools. Teachers' main goal for using digital technology in the classroom appears to be practical enhancement; qualitative enhancement has received much less attention. Therefore, it is important to focus more on teachers' professional development activities that have an effect on their mindset and result in a critical revision of their goals and practices. The Educational Technology master's program introduced in this chapter is one good example of the desired programs. However, to scale such programs up to involve all schools, learning communities should be established and supported in schools.

Keywords: digital competence, educational technology, DigiEfekt, Estonia

Introduction

Estonia has been branded as a "digital education nation" (see Forsman et al., 2023; Mehisto & Kitsing, 2022). This is based on two sets of analyses, one describing country level comparisons of digital readiness and the other the academic achievement of students in Estonia. For example, according to the Index of Readiness for Digital Lifelong Learning developed by the Jobs & Skills Unit at the Centre for European Policy Studies (CEPS), Estonia is ranked as the country with the best digital readiness among the 27 European Union countries included in the analysis (see Beblavý et al., 2019). However, in the World Digital Competitiveness Ranking list developed by the International Institute for Management Development (IMD), Estonia is not at the top – in 2022, Estonia was in 20th place among the 63 countries included in the comparison (IMD, 2022). Another example that is directing us to ask additional questions is from the Teaching and Learning International Survey (TALIS), which focuses on teachers, teaching, and learning environments. According to the survey, only 29.7% of Estonian teachers feel prepared for the use of information and communication technologies (ICT) for teaching (see https://www.oecd.org/education/talis/talis-2018-compare-your-country.htm). Of course, this result might be explained by the rather self-critical stance of Estonian teachers compared to several other countries where teachers might overestimate their digital readiness; however, it still clearly demonstrates that there are several challenges to be faced in the Estonian context to support digital learning in Estonia. Thus, it could be concluded that according to the framework for digital transformation introduced by Luo and Wee (2021), Estonian schools and teachers have long passed the Digitization stage, but for some reason, they are stuck in the stage of Digitalization without advancing to the Digital Transformation stage. This chapter aims to shed some light on the possible reasons, and to suggest some ideas for moving forward.

The academic achievement of Estonian students is often compared with other countries based on the Program for International Student Assessment (PISA). According to PISA results, Estonia is among the ten best countries in the world in all three dimensions covered: math, science and reading skills (see https://gpseducation.oecd.org/CountryProfile?primaryCountry=EST&treshold=10&topic=PI).

However, every medal has two sides, not just the bright one. According to the same PISA study, students in Estonia seem to exhibit some of the lowest levels of positive feelings, ranking 64th out of 69. This might also be one of the reasons for their weak interest in studying further and pursuing a career related to math, science or languages. As a result, there is a significant shortage of teachers (PISA ranking 6 out of 78), especially in math and science. Teachers therefore need to find smart solutions for sustaining the quality of education in a situation of high workload due to the increased number of students in classes and having more lessons per week to provide high-quality education to all children. Digital tools can be of great value in assisting teachers with planning, guiding, monitoring and giving feedback. Also, they can support students in various self-regulation processes, which are of paramount importance. For example, a recent survey investigating Estonian K-12 teachers' expectations related to Artificial Intelligence provided important insights into the major areas of concern (see Chounta et al., 2022). When asked what they would focus on if they could have a superpower at their disposal, Estonian teachers mentioned as priorities effectiveness, efficiency, rapport with students, course planning, personal attributes and personal skills. This shows that teachers see a great deal of potential in digital learning, but this dream has not yet come true.

In conclusion, it can be said that Estonia's education system has several remarkable results in international comparisons, and this increases our responsibility in educational innovation and related research. At the same time, our teachers and students are facing their own challenges, leading to the point where teachers do not feel competent in digital learning, which might also affect students. The following sections offer an introduction to the Estonian education system and outline the authors' views on the digital competence required for digital learning and teaching. After that, two cases are shared that illustrate how students and teachers are implementing digital technologies in Estonian K-9 education, and how the authors have contributed to the professional development of educators. More specifically, the former is done based on a large-scale national study called DigiEfekt, and the latter is based on the authors' experience in the Educational Technology master's program supporting educators' outlook on digital learning and teaching. For the discussion, these examples are linked to the framework for digital transformation to identify trends and issues in digital learning.

Education in Estonia

The Estonian education system supports the lifelong learning approach. This means that structures have been created that enable learning throughout one's life. Most Estonian children attend kindergarten, although it is not compulsory. Formal and compulsory schooling starts at age seven and lasts for nine years in basic school, which is divided into three levels, each lasting three years. Teachers at the primary school level usually teach most of the subjects themselves, which lends a lot of flexibility to integrate various subject areas. Often, students do not get numerical grades at this level, but supportive constructive feedback. Starting from grade 5 or 6, different subjects are usually taught by subject-specific teachers: e.g., science (or from grade 7 or 8, there are separate courses for biology, geography, physics and chemistry) is taught by a teacher who is a graduate of a science program and has completed a teacher education program after that or in parallel. After graduation from basic school, at age 15 or 16, students usually continue their studies – either in a secondary school (general educational studies, mainstream among the students) or in a vocational education school (where the program consists of both general and vocation-specific courses). However, vocational education schools also offer programs for those who do not aim for a certificate of secondary education. When the certificate of secondary education has been awarded, however, it does not matter if it is from a general secondary education focused school or from a vocational education oriented school. In both cases, students graduate with a degree that allows them to continue their studies in higher education, in either universities or other higher education institutions. What is more, according to the goals of the recent Education Strategy of Estonia, general and vocational education are expected to merge even further in the coming years. In higher education, three levels are distinguished: the first ends with graduation at the baccalaureate or an equivalent level, the second at the master's or equivalent level, and the third at the doctorate level. An overview of the Estonian formal qualifications system is given in Figure 1.

Figure 1 Estonian Formal Qualifications Framework

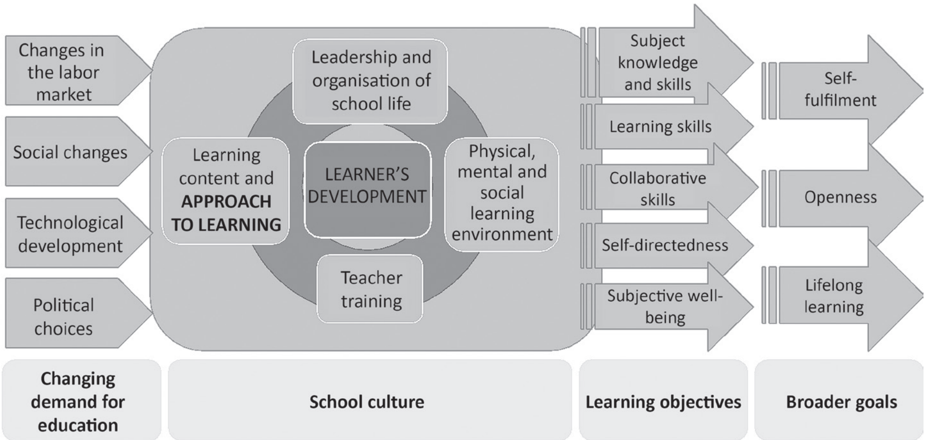
Estonian Qualification Framework Level	Qualification			
8	Doctoral Degree			
7	Master's Degree	Degree in Medicine	Degree in Dentistry	Degree in Veterinary Medicine
6	Bachelor's Degree			
5	Certificate of Specialized Vocational Education			
4	Certificate of General Secondary Education	Certificate of Vocational Secondary Education	Certificate of Vocational Education Level 4	
3	Certificate of Vocational Education Level 3			
2	Certificate of Basic Education	Certificate of Simplified Basic Education Program	Certificate of Vocational Education Level 2	
1	Certificate of Moderate Learning Disabilities Program			

In the Estonian context, the education system is considered the country's key means of building its national identity and developing society (see Jürimäe, 2022). It has been so for centuries, and it has not changed. In the times of occupation, the education system helped people maintain their identity and the Estonian language. The education system has enjoyed a considerable amount of autonomy throughout history. Teaching and learning in schools is mainly guided by the national curriculum and teacher professional standards. The national curriculum consists of a general part and subject-specific curricula (see Põhikooli riiklik õppekava, 2023). The general part defines the basic values of education, general goals and eight generic competences, including digital competence. In addition, there is an introductory part related to the concept of learning (e.g., focus on outcomes, adaptation to learners' characteristics, application of contemporary learning approach), learning environment (where mental, social and physical aspects support the development and learning process) and expected learning outcomes at the end of different study levels. Finally, there are several paragraphs defining formal regulations, for example, how many classes there are for different subjects, how parents are informed of their children's progress, how assessment is organized, and what the requirements are for graduation. The subject-specific curricula define mainly learning outcomes and integration of different subjects. The outcomes consist of knowledge, skills and attitudes. However, a great deal of autonomy has been left to teachers. They decide how to achieve the expected learning outcomes: what methods to use, how much time to spend on a topic, when to use digital technologies, or where and how to conduct lessons (e.g., in school, in a museum or as outdoor activities).

Teacher professional standards regard teachers as learning professionals who should continuously keep their teaching competence up to date (see Pedaste et al., 2019). In addition, it is expected that they contribute to the development of the teachers' community, at least at their school, but preferably at the regional and national level as well. The standards are designed to support teacher autonomy and authority based on their commitment and integrity. This means that there are specific standards for teachers, senior teachers and master teachers to support their professional development. In all of them, six compulsory competences are listed: (1) supporting the learner, (2) planning learning and teaching activities, (3) teaching, (4) reflection and professional development, (5) collaboration and counselling, and (6) research and development and creative activities. Moreover, there are 11 competences that are linked to all compulsory competences, for example, using correct language, creating a positive atmosphere, following professional ethics, collaboration, and digital competence. Finally, there are two elective competences, one of them focusing on digital pedagogy – how to create digital learning materials that could be used by other colleagues as well, how to lead and contribute to the analysis of digital infrastructure at the institutional level, and how to support curriculum development with the integration of digital technologies. According to Pedaste et al. (2019), these standards are successfully used to design pre-service education and award teacher certificates at the end of the higher education studies (all schoolteachers in Estonia are required to have a master's degree). However, the standards have less of an impact on the regular assessment of in-service teachers' competences and the design of professional development plans.

Besides the national curriculum and teacher professional standards, educational practices in Estonia are guided by national strategies, for example, the Estonian Education Strategy 2021–2034 (2021). According to that document, the general objective of the Estonian education system is "to equip the population of Estonia with the knowledge, skills and attitudes that prepare people to fulfil their potential in personal, occupational and social life and contribute to promoting the quality of life in Estonia as well as global sustainable development" (p. 2). Three strategic goals are specifically defined: (1) to provide diverse learning opportunities and enable a smooth transition between levels and types of education, (2) to support the competence and motivation of teachers and heads of schools so that the learning environment would be learner-centered, and (3) to ensure flexibility and responsiveness of the learning options according to the needs of society and the labor market. More specifically, a framework for contemporary learning has already been created based on the previous version of the national education strategy (see Õpikäsitus, 2017). According to this (see Figure 2), there are three general broader goals for the learning process: self-fulfillment, openness and lifelong learning capability. However, these have been considered too broad and vague to be assessed. Therefore, more specific learning objectives have been defined: subject knowledge and skills, learning skills, collaborative skills, self-directedness and subjective well-being. These should be considered by all teachers in the learning and teaching process, including activities with digital technologies. On the left of the figure, it is explained why we need to regularly consider changes to our learning approach – it is because of changes in the labor market, social changes (like the current situation of increased numbers of refugees), technological development (like the recent rapid advancements of AI based tools in education) and political choices. In the middle of the framework lies school culture, serving as the "mediator" between demands on education and expected learning goals. At the center of the school culture stands the learner or, more specifically, their development, which is supported by the leadership, environment, teacher training, learning content and approach to learning.

Figure 2 Framework for the Contemporary Learning Approach in Estonia



Note. Based on Õpikäsitus, 2017.

Digital learning is directly linked to various elements of the contemporary learning approach. For example, changes in the labor market increase the demands on computational thinking and use of existing digital technologies in different professions. Social changes set the demand for effective communication with people who do not speak the language of instruction of a school, for example, in the case of refugees who speak only Arabic or Ukrainian or other languages not spoken by the teachers or peers. Technological development has provided us with AI-based tools such as ChatGPT, and there is an ongoing hot debate worldwide, Estonia being no exception, about the need to integrate AI into the learning process, or to set restrictions on its use in learning and assessment. One of the political choices made by the Estonian Ministry of Education and Research related to digital learning is the adoption of digital learning goals and, more broadly, smart specialization goals in their strategic documents. A conspicuous amount of money from the Estonian state budget and European structural funds has been allotted for building the structures and providing education that would help society benefit from digital technologies in the teaching and learning process and in many other areas.

In the context of school culture, practically all Estonian schools have adopted a Learning Management System that not only allows smooth communication between teachers, the school leadership team, students and parents, but also enables students to upload their coursework, give and receive feedback, interact with learning materials, including those consisting of rich media, and so on. Often, schools have identified digital competence, in one way or another, as a goal in their strategic development plans. What is more, this is also true for kindergartens. Usually, schools and kindergartens have no significant technical limitations in terms of hardware, software or internet connection, which means that the use of digital technologies comes down to the teacher's willingness to invest time in learning how to use them meaningfully. One of the main challenges hindering educational innovation seems to be teachers' workload, which is considerably high due to the shortage of teachers. In this situation, teachers only have limited time to invest in continuous professional development, although international comparisons show Estonian teachers quite actively participating in various in-service courses. Professional development activities for teachers are normally provided by the universities that are also responsible for pre-service teacher education. In a small country like Estonia, all processes tend to be connected, which results in a very closed system – it is the same people who contribute to the development of the national strategies, national curriculum, teacher professional standards, pre-service and in-service teacher education programs, national testing of the learning outcomes or school satisfaction, and research related to the above-mentioned topics. Another challenge related to this situation is that some of the university staff members are heavily overloaded and cannot delve into topics in any great depth. In some cases, this has also resulted in burnout, and sometimes it is difficult to recruit new staff.

In the context of learning objectives, all five listed in Figure 2 are related to digital learning. For example, many digital learning materials have been developed in Estonia or have been translated to acquire subject knowledge and skills. A large collection of the materials has been systematized and made freely available to all teachers and students through an online repository called eSchool bag (see https://e-koolikott.ee/en). In this environment, teachers can reuse the existing learning materials, adapt them to their specific needs, or create new ones. The variety of the learning materials is also quite rich: videos, presentations, games or simulations, tests, studies or projects, guides, knowledge testing, exercises or worksheets, textbooks, courses or texts, lesson plans, sources of information, sounds, and images. As of May 2023, there were almost 2,000 different learning materials. In addition, teachers actively use learning materials developed in several international projects in which Estonian researchers have actively collaborated, e.g., Go-Lab (see https://www.golabz.eu/; de Jong et al., 2021), WISE (see https://wise.berkeley.edu/; Linn et al., 2003), Ark of Inquiry (see https://arkportal.ut.ee/; Pedaste et al., 2015), and PhET (see https://phet.colorado.edu/; Wieman et al., 2008).

Learning skills, collaborative skills, self-directedness and well-being are also tightly linked to digital learning. It means that schools focus on learning strategies in digital learning environments, including those for collaborative learning activities. In 2020, due to COVID-19 related closures, schools were forced to switch to online and hybrid learning. This was not unfamiliar to schools. Most of them were ready to face the emergency because they had already experimented with online learning during the so-called e-learning days, when students got their assignments and learned on their own at home while teachers were focusing on something else, such as their own professional development or development of strategic plans for the school. The studies conducted by Lepp et al. (2021), Rannastu-Avalos and Siiman (2020) and Adov and Mäeots (2021) showed how teachers flexibly adapted to the emergency. Lepp et al. (2021) showed how teachers' teaching-related decisions depended on the existence of digital tools and the ability to use them purposefully by students at home. Short-term goals, such as maintaining students' social interaction and supporting student motivation, became the leading factors in their decision making. Thus, students' well-being was highlighted more explicitly than before COVID-19. More specifically, Adov and Mäeots (2021) identified three groups of teachers who differed from each other in their willingness to use technology, change in their technology use from pre-COVID to distance learning, and variety in their use of technology. In addition, they identified several external (e.g., issues with the internet connection, lack of students' digital skills) and internal (e.g., teachers' beliefs about technology use for teaching) factors affecting teachers' decision making. Finally, they also noted students' poor digital skills as a limiting factor in designing a learning process for online learning in groups or self-regulated individual learning. Rannastu-Avalos and Siiman (2020) focused on science teachers and found that teachers mostly reported using video conferencing tools to engage in synchronous communication with students. Schools' learning management systems were mainly used for sharing information. They also found that the new distance education setting was challenging for collaborative learning. The DigiEfekt project, which started a bit later, showed that the same challenges persisted even after the end of the COVID-19 crisis, in the academic year 2021-2022.

Digital Competence for Learning and Teaching

As previously described, there are several challenges in Estonia when it comes to applying digital technologies meaningfully according to the contemporary learning approach, which guides educational decision-making in Estonia. One of the key factors of success in this context is digital competence. The first author of the chapter has proposed, together with several colleagues, a Framework for the Digital Competence for Learning and Teaching. It is based on a synthesis of mainly the ideas of Gallardo-Echenique (2015), Ilomäki et al. (2016), Krumsvik (2011), Martin (2009), Redecker (2017), and Spante et al. (2018). Redecker (2017) described the European Framework for the Digital

Competence of Educators (DigCompEdu). The framework defines six areas educators need to focus on to assess and improve their competence for teaching and learning: (1) professional engagement, (2) digital resources, (3) teaching and learning, (4) assessment, (5) empowering learners, and (6) facilitating learners' digital competence. This framework has been used in the Estonian context to support teachers' professional development, and is used as a basis for teacher professional standards for guiding teachers towards the assessment and improvement of their competences. It is also in line with most of the dimensions of digital competence described by Gallardo-Echenique (2015), Ilomäki et al. (2016) and Spante et al. (2018) in their reviews for operationalizing digital competence in a broad or more specific context, for example, higher education. However, they do not focus on the interesting hierarchy of the dimensions of digital competence that was introduced by Martin (2009) and Krumsvik (2011). Martin (2009) differentiated three levels of digital literacy: (1) digital competence (skills, concepts, approaches, attitudes, etc.), (2) digital usage (professional/discipline specific application) and (3) digital transformation (innovation/creativity). The European DigCompEdu framework focuses on elements of the first two levels, but not explicitly on those of the digital transformation level. However, even the elements of the first two levels are not clearly distinguishable – there is no distinct line between generic and contextualized knowledge, skills and values necessary for performing successfully in the digital learning process (see Pedaste et al., 2022). Krumsvik (2011) differentiated the levels of digital Bildung. He described the increase in self-awareness and practical proficiency through phases of adoption, adaptation, appropriation, and innovation. Similar to Martin's (2009) framework, teachers and teacher educators, the particular focus of that framework, should move from usage of the existing digital technologies to innovation – creative development of new ways of technology use through critical reflective thinking where all ethical aspects, sustainable development goals and other relevant principles are considered.

Inspired by the aforementioned discussion, the authors' Framework for the Digital Competence for Learning and Teaching identifies eight areas of competences, situated on three different levels (generic, contextual, transformative). Additionally, two different focus areas are singled out, namely, starting from the personal/individual competence and moving towards collaboration in a community of professionals for common good in the society, and considering the effect on the environment (Figure 3). In short, generic competence constitutes the ability to use technologies, related knowledge, beliefs and values, emotions as well as motivation towards digital technologies. Contextual competence, on the other hand, means contextualization of digital technologies and their use at the individual level and in collaboration with colleagues/peers. Transformative competence consists of creative adaptation of digital technologies in professional contexts and their ethical and responsible use. The framework could be further used for developing tools for assessing digital competence in different contexts and for designing interventions focusing on areas most in need of improvement. In this chapter, the framework guides the discussion of the cases introduced later.

Figure 3 Framework for the Digital Competence for Learning and Teaching

Focus on community/ society/environment	Transformative competence	8) Ethical and responsible (critical reflective) use of digital technologies 7) Creative adaptation of digital technologies in professional contexts
	Contextual competence	6) Collegial contextualization in using digital technologies in particular contexts 5) Individual contextualization (planning, monitoring, evaluation and reflection) in using digital technologies in particular contexts
Focus on individuals	Generic competence	4) Emotions and motivation towards digital technologies 3) Beliefs and values towards digital technologies 2) Knowledge (awareness and understanding) of digital technologies 1) Abilities (skills) to use digital technologies, both hardware and software

More specifically, at the generic level, we are interested in the following:
Abilities: What is educators' proficiency in using digital technologies needed in the learning process? What is educators' proficiency in using digital tech-

nologies for assessment?

Knowledge: How well do educators know how to use digital technologies to promote learning?

Beliefs and values: What is educators' self-efficacy in using digital technologies? How confident are educators in creating digital learning environments? How do educators value digital technologies for learning? What are educators' attitudes toward the use of digital technologies (ease of use, usefulness and compatibility of technologies) in learning and teaching?

Emotions and motivation: What emotions do educators associate with the use of digital technologies? How motivated are educators to use digital technologies?

In the case of contextual competence, we are focusing on two aspects:
Individual contextualization: What are educators' goals in using digital technologies for learning and teaching? To what extent do educators support learners' use of digital technologies? To what extent do educators support the implementation of effective strategies for using digital technologies in learning? To what extent do educators express supportive pedagogical beliefs about the use of digital technologies?
Collegial contextualization: To what extent do educators learn from each other and mentor others in the contextual use of digital technologies? To what extent do educators collaborate with others in the contextual use of digital technologies? To what extent do educators reflect on the contextual use of digital technologies?

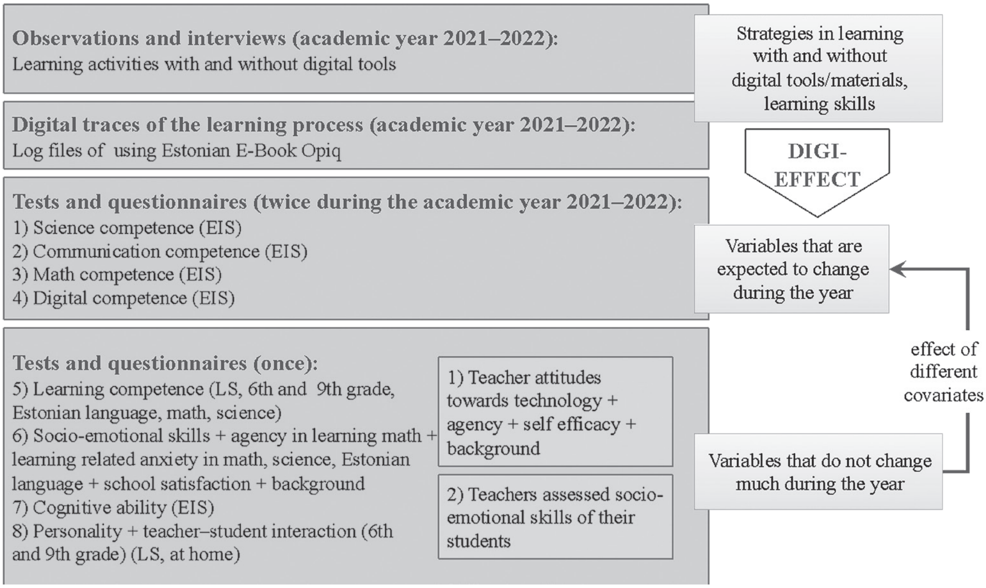
Finally, at the level of transformative competence, the following two dimensions are specified.
Creative adaptation: What is educators' competence for innovation? To what extent do educators express and apply innovation and an inquiry-oriented attitude in using digital technologies, and thus serve as role models for learners?

Ethical and responsible use: To what extent are educators role models for learners in the ethical and responsible use of digital technologies in their teaching? To what extent do educators raise ethical and critical issues related to the use of digital technologies and learning environments (e.g., in using social media or artificial intelligence)?

The Status of Digital Learning

Digital learning in Estonia can be described based on the large-scale study conducted in the DigiEfekt project. In this study, we focused on both students and teachers, and collected different types of data during the 2021-2022 academic year (see Pedaste et al., 2023). First, students' learning activities in math, science and Estonian language classes were observed, and teachers were interviewed right after the classes to understand their goals (see Figure 4). In addition, students' learning activities in a widely used collection of E-Books were logged. Finally, several tests and questionnaires were administered to describe students' competences and background information that should be taken into account in drawing conclusions about the effect of different learning strategies on both cognitive and non-cognitive learning outcomes, science competence, communication competence, math competence, digital competence, learning competence, and socio-emotional skills, in particular.

Figure 4 Design of the DigiEfekt Study



Digital technology integration in classrooms

The analysis of the observations and interviews revealed that 82% of 169 lessons in the 3rd, 6th or 9th grade consisted of some type of activities where digital technology had been integrated (Raave et al., 2022a). However, the data showed that the practices seemed to be rather limited. For example, according to Puentedura's (2006) framework distinguishing Substitution, Augmentation, Modification and Redefinition (SAMR), teachers mainly gave students tasks where digital technology was only employed in a substitutional role – 71% of activities were in this category (Raave et al., 2022b). Augmentation was evident for 33% of learning activities, and modification or redefinition for only 3% and 6%, respectively. More specifically, among the substitution activities, the most common was presenting the learning content on a large screen, which formed about half of the cases of digital technology use. Very often, various digital interactive learning environments were used, for example, Opiq (the largest Estonian collection of E-Books), Geogebra, Learningapps, Liveworksheets, Matific, Wizer.me, as well as several materials in Estonian. Video-based platforms (YouTube and Vimeo) or gamified testing systems (e.g., Kahoot!, Quizziz, Socrative, 99Math, JeopardyLabs, CrosswordLabs, PurposeGames) were also used quite often. There were some differences in using digital technologies between the 3rd, 6th and 9th grade and math, science and Estonian language classes. These were not remarkable, however.

In addition to the SAMR framework, observation data were analyzed based on the ICAP framework distinguishing interactive, constructive, active and passive learning activities (Chi & Wylie, 2014). According to the analysis, constructive activities were the most common, while the others were used with similar frequency (see Raave et al., 2022c). The ICAP framework states that interactive activities are more engaging and lead to better learning gains compared to constructive activities; constructive activities in turn are more engaging than active activities; and active activities are more beneficial than passive ones. Thus, the digital learning activities in Estonian classrooms are rather engaging, although less valuable passive or active learning also occurs on many occasions.

The analysis of teacher interviews revealed three categories of goals of digital technology integration (Raave et al., 2022b). First, teachers most commonly aimed to use digital technologies because of some practical reasons, for example, availability of appropriate content, students' easier access to learning tasks or content, and greater ease of monitoring the learning process and giving feedback. The other two aims, engaging students (e.g., triggering interest) and increasing the quality of the learning process (e.g., activation of preknowledge or deeper understanding or practicing routines), were slightly less common.

Teacher and student characteristics and environmental conditions affecting digital learning

The classroom digital technology integration practices might be mediated by teacher or student characteristics, but also by environmental conditions for applying digital technology. Therefore, we also analyzed those aspects. The analysis of teachers' digital readiness showed that, on average, there were no significant issues in applying digital learning (Pedaste, 2022). On a 4-point Likert type scale, 91 teachers were asked if they were restricted in their digital technology use by lack or inappropriateness of either digital devices, digital learning environments or digital content; in all cases, the average score was 2, meaning that they did not agree to being restricted by those factors. At the same time, they mostly agreed to having in their schools enough digital devices connected to the Internet, a good quality Internet connection, the necessary learning software, and sufficient technological and pedagogical knowledge and skills for applying digital technologies in teaching and learning. However, they did not agree to having enough time for planning and designing lesson plans involving use of digital technology. In addition, they also found that they were not sufficiently encouraged to use digital technologies – no incentives were provided by their schools. Despite the digital readiness supported by the availability of tools, content, and knowledge and skills needed, the teachers' attitudes towards using digital technologies for teaching and learning were not so positive. On a 6-point Likert type scale, the score for behavioral attitudes was 4.2, perceived control 4.4, and behavioral intention only 3.1. Thus, teachers often lacked willingness to use digital technology and preferred other formats of learning if possible, despite the fact that the environmental conditions did not appear to restrict digital technology integration.

In the case of students, we assessed their digital competence for learning based on a framework in which two higher-order latent variables were described: (1) attitudes towards digital device usage and (2) skills of using digital devices and behavior in digital learning environments (Pedaste, et al., 2023). More specifically, nine lower-order latent variables were distinguished: perceived control, behavior-related attitudes, behavioral intention, creation of digital materials, digital content programming, communication in the digital world, performing digital operations, legal behavior in the digital world, and protection of oneself and others in the digital world. The results showed that compared to their teachers, the students had more positive attitudes towards using digital technologies for learning in all three dimensions of attitudes measured. The most significantly more positive were students' behavioral attitudes; for example, they were not frightened of using digital devices, they were not nervous about using them, and they were not confused and did not experience difficulties when learning in digital environments. As for perceived control, it was higher for 6th- and 9th-grade students, but not for 3rd-graders. Behavioral intention was higher for students in all grades; however, there was a remarkable change, with an increase from the 3rd to the 6th grade and a decrease from the 6th to the 9th grade. In the skills and behaviors assessed, there was a significant increase in all competence dimensions from the 3rd to the 6th and from the 6th to the 9th grade. As expected, programming skills were not very good; however, it came as a surprise that two other dimensions, performing operations with digital tools and legal behavior in the digital world, also showed quite low average scores.

Mediation of technology use

One more topic of interest in the DigiEfekt project was students' technology use, both in general and in the context of learning. More specifically, the question was how technology use can be mediated by the rules and restrictions they have. It has been shown that schools have in fact placed many restrictions on the use of digital technologies (Puusepp & Pedaste, 2022). Sometimes, there are limitations on using computers or smartphones, and conditional restrictions (when and where one is allowed to use personal digital devices) are quite common. Moreover, it seems to be rather customary to have restrictions on the use of Wi-Fi – a usual practice is to have separate networks for teachers and students. At home, parents also mediate their children's technology use. Data were collected from both children and their parents, and the results turned out to be somewhat different. In general, children did not perceive having as many rules and restrictions as their parents reported. The most common were restrictions on using digital devices (e.g., how many hours a day, when or on what conditions their smartphones, tablets or computers could be used). In addition to that, three more categories of restrictions were specified: environment-related (e.g., restrictions related to YouTube, Facebook, Discord), content-related (e.g., restrictions related to different types of content and different activities with the content – downloading games or apps, rules of courtesy in online communication, age-specific restrictions), and Internet connection related (e.g., Wi-Fi or data volume related). The older the children, the fewer restrictions they had. In conclusion, it seems that the restrictions at both school and home were not so much related to digital learning as to the general use of digital technologies.

Professional development of educators' competence for digital learning

Educators' professional development for digital learning has been supported by several courses for pre-service and in-service teachers. However, at the University of Tartu, a special master's program has also been designed for all educators at different educational levels. The aim of the program is to give educators the chance to upskill themselves for a more meaningful use of educational technologies and for guiding others in revising their existing practices and doing research in the field. Therefore, it is a good example of how educators' competence for digital learning is supported in Estonia.

The Educational Technology master's program was officially launched in August 2017. Since its inception, the program, which is one year long, has been advertised as "almost fully online." The "almost fully online" refers to the fact that students and teaching staff members meet at the beginning of the academic year for an intense period of study lasting for about 10 to 12 days in the second half of August. After that, from September to its end in June, the study sessions continue in an exclusively online format. In this sense, the program meets the basic requirements to be considered a blended program, as it is a mix of traditional face-to-face learning with online learning (Alammary et al., 2014). While the term "blended learning" lacks a precise definition in higher education (Castro, 2019), in the context of the program, "blended" refers to the combination of classroom interaction with learning through thoughtful online activities, in which instruction can be differentiated from student to student.

The decision to have a blended format was justified in the light of providing an opportunity for adult learners to learn with and about educational technologies, which is the reason why the program became part of the postgraduate offerings at the University of Tartu. Currently, only those already with a master's degree or at least 5 years of experience in educational institutions are eligible. Additionally, the specific format was also meant to create an international community of people interested in educational technology, which, as we will see, has been one of the pillars of the program.

While in-service teachers have been the most represented category among the educational practitioners that the program attracted, throughout the years, the program has housed different profiles of practitioners such as human resource specialists, entrepreneurs in the field of educational technology, as well as coaches, university lecturers and even parents involved in homeschooling their children.

The curriculum of the program went through several rounds of development, which were also supported by the Erasmus+ project called "MA in Educational Technology: A New Online Blended Learning Program for New Member states" (Key Action: Cooperation for innovation and the exchange of good practices). During the project, which coincided with the first three iterations of the program (2017–2020), Utrecht University served as a partner during the curriculum development activities with a specific evaluation plan. The evaluation plan helped the teaching staff members and program director to identify areas of concern and development.

The current curriculum reflects the general approach to educational technology, which tries to integrate synergistically three main aspects:
(1) *theory* through the introduction of contemporary pedagogical frameworks with courses dedicated to problem-solving, self-regulation and the new learning paradigm, which includes digital competence frameworks;
(2) *practice* through the contextualization of educational technologies with courses such as "Technology Use in Education" and "Educational Design for Complex Learning Tasks;" and
(3) *reflexivity* through the development of a deeper understanding of the role of technology in education and society with courses such as "Critical Issues of Technology Use in Education."

In this sense, we may say that the curriculum reflects the idea of going beyond the two main approaches to educational technology, namely, the technology-led and pedagogy-led approaches. In line with the idea of entangled pedagogy (Fawns, 2022), the curriculum has a strong emphasis on the "contextualization" of digital technologies and the transformation of the teaching and learning practice through digital technologies.

In a survey that was distributed among former students at the end of 2020, the transformational impact of the program was highlighted. For example, one former student emphasized that "the program provided not only great content to learn, but for me the actual experience of how the sessions were organized is what I will use in my future practice." Another student referred to their study period as a fundamental experience to help their colleagues during the pandemic. Others stressed that the master's program allowed them to reach a "deeper integration of existing (and new) technology use in the workspace."

The emphasis on contextualization is also reflected in the design of assignments in the mandatory courses, which are tied to the students' own professional practice. This is supposed to facilitate the transfer of the learning to one's own practice, and to handle the intricate relationship between theory and study on the one hand and practice and work on the other. This is in line with the idea that blended learning combines what students learn with actual job tasks (Driscoll, 2002). For example, in some courses, students are supposed to conduct observational tasks in an authentic learning setting (e.g., a school), while in others, the final assignment is a project to be implemented in one's own professional setting.

As mentioned above, most courses are online and have activities that are both synchronous and asynchronous, with the flipped classroom as the main method used. The synchronous activities, namely webinars, are not organized as traditional online lectures but as discussions, which are introduced by a task to be performed before the webinar. The nature of the task may differ. It can be based on materials to be read, videos to be watched, or an activity to be performed in a group and/or at one's workplace. In some cases, those tasks are graded and count towards the final assignment. Incidentally, the fact that virtually all mandatory courses have webinars has been an important pedagogical cornerstone of the program in order not to lose the social and community aspect of learning, which has been one of the main pillars of the learning experience the program has contributed to.

The master's program is part of the postgraduate offer of the university. But what kind of profession does the master's program prepare for? Currently, the program does not provide any teacher qualifications. However, throughout the years, the program turned out to be particularly useful for three main categories of professionals. The first is those in-service teachers and university lecturers who want to transform their own teaching practice with the help of technology. The second category is composed of those who do not simply develop their own digital competence but want to help others do so and lead innovative processes in their own organization. In Estonia, this is the role of the so-called "educational technologist" (Lorenz et al., 2014; Bardone et al., 2020). The educational technologist, who is not to be mistaken for an IT specialist, has the main function of introducing digital technologies through workshops to teachers, assisting them in incorporating new tools into their own practice, and even creating a vision concerning educational innovation for the whole organization. In the aforementioned survey, one of the students remarked that they are now "much more able to support my colleagues in implementing technology into their classrooms. I am able to see opportunities where technology would be beneficial to myself, my students or my colleagues." Another student observed, "I feel much more experienced than my colleagues and I help them anytime." The third and last category comprises those who are interested in an academic career, in which the first step is enrolling in a doctoral program. In the last 5 years, more than a dozen graduates from the program have eventually started a doctoral degree in educational research in Estonia or elsewhere (e.g., the UK, the Netherlands, Latvia, the US). In the same survey, one student pointed out that the program gave them confidence and credentials to pursue a doctoral degree.

As anticipated, one of the pillars of the program is the community dimension that emerged around the formal teaching and learning activities, and constitutes a fundamental component of the blended learning experience that the students receive. The fact that the program is online with the sole exception of the 2-week onsite session at the beginning of the academic year in August allowed the emergence of a cosmopolitan community of learning and practice, which is now running parallel to the program. Over the past 6 years, virtually all continents have been represented. We have had students from Western and Eastern Europe, the Balkans, Scandinavia, the UK, Africa, North and South

America, Australia, and Asia.

Besides its multicultural nature, the community dimension has been one of the main elements praised by the students themselves. In a series of videos called "From the Horse's Mouth" available on YouTube (https://youtube.com/playlist?list=PLxW5WmVB6QbnbIIIQ6tQ3IW-EhJOPk4bO), they were asked to reflect on their experience in the program. Students highlighted "the sense of togetherness" that emerged during their studies, which also involved the teaching staff members, who were seen as partners during their learning rather than mere gatekeepers. This sense of being together was an active part of the learning process. As one student remarked in one of the videos, "when we discover something we're all very, very eager to share it with each other." Others have singled out the connection with their cohort as "probably the most valuable thing I'm currently getting out of the program."

As mentioned, the sense of being a community has grown parallel to the program itself, which has constituted some kind of catalyzer of interests. For example, over the past two years, several online events have been organized by former students with the specific intention of promoting educational technology. Such events included, for example, webinars concerning women in educational technology, the role of parents, democratic education, and so on. An online event called "EdTest Estonia," which was meant to establish synergies between the private sector and educators, brought together 20 EdTech companies around the globe and 40 teachers.

Trends and Issues in Digital Learning

This section is devoted to taking stock of what has been presented so far, and discussing trends and issues in digital learning in Estonia. First, it seems that the infrastructure – not only digital devices and the Internet but also learning management systems and other learning environments – as well as content are available for digital learning. However, it appears that not enough attention is paid to collaboration and interaction of learners with each other or with the teacher, as demonstrated by Rannastu-Avalos and Siiman (2020) in their study based on a small number of teacher interviews, and corroborated by Raave et al. (2022c) based on the large-scale quantitative DigiEfekt study. According to the ICAP framework (Chi & Wylie, 2014), interactive assignments are more engaging than constructive, active or passive assignments. Thus, teachers' decisions to focus more on constructive assignments and to use a significant number of active or even passive assignments might have affected students' willingness to study using digital technologies. In the light of the recent developments, technology has even more affordances for interactive use, as ChatGPT and Natural-Language Processing (NLP) based solutions could at least partially replace or mediate human interactions in a dialogue-based interactive learning process. Good overviews of synergies between educational technologies and learning sciences have been presented by Linn et al. (2023) and Gerard and Linn (2022). They reported on cases where NLP-based technologies (e.g., visualization, collaborative tools and automated guidance) have been effectively used in scaffolding learners and supporting teachers in guiding their students in real time, and supporting them in a self-directed learning process. In the context of Estonia, Siiman et al. (2023) showed that ChatGPT responses to students' collaborative problem-solving assignments might be of better quality than those of human experts, suggesting that AI-assisted qualitative analysis has the potential to improve the learning process. Thus, there are good cases showing the benefits of digital technologies for fostering interactive digital learning, but it seems this has not yet entered the mainstream of Estonian schools.

Another finding worth discussion is that the learning goals of teachers in the digital learning process are mainly focusing on practical enhancement, but less on qualitative enhancement (Raave et al., 2022b). Practical goals of making the learning materials easily accessible and the learning process more visible for monitoring and giving feedback are certainly necessary; however, they might not be sufficient. It might be more important to focus on eliciting students' ideas, making them visible to other learners to start an active discussion; the active discussion would involve considering alternative ideas and later revising the learners' initial ideas in a guided reflection process, as described in the Knowledge Integration Framework (see Linn et al., 2003). Technology offers several affordances for activating pre-knowledge (e.g., mind-mapping tools or interactive collaborative online whiteboards) and organizing alternative ideas on idea-maps to learn from an interactive collaborative process. However, these innovative pedagogical ideas have not often been considered in the learning process, as revealed in the observations and interviews of the DigiEfekt project in the context of Estonia (Raave et al., 2022b).

The digital learning outcomes could also depend on the way of using technology. The results of the DigiEfekt project showed that teachers rarely modified or redefined their teaching and learning activities when using digital technologies (Raave et al., 2022b). It means that teachers tend to use the same methods in digital learning that they would use in a more traditional learning process that does not involve technology. In Estonian classrooms, digital technologies have been used mainly for substitution, and slightly less for augmentation. According to Puentedura (2006), these two ways of technology use are where the traditional learning goals and activities could be used in the new context of using technology. However, in addition to substitution and augmentation, it is also important to think about modification and redefinition if our aim is to harness the full potential of technology in a way that is meaningful for both learners and teachers. This might also lead to better learning outcomes, and not only better academic outcomes but also better non-cognitive learning outcomes, such as subjective well-being or socio-emotional skills.

Overall, the lack of interactive assignments, learning quality-oriented goals, and modification and redefinition of learning activities might be the reasons why students' attitudes are not very positive towards replacing other types of learning activities with those involving use of digital technologies. If teachers need to invest a lot of time in integrating digital technologies into the learning process and the students do not appreciate it, teachers' willingness to use digital learning also suffers. This might explain Estonian teachers' rather low scores on positive attitudes towards using digital technologies in the learning process, as demonstrated by the DigiEfekt study. The solution might be increasing the meaningfulness of digital learning. According to the authors' Framework for the Digital Competence for Learning and Teaching, Estonian teachers are mainly competent at the generic or contextual competence levels, but there are not many signs of transformative competence, that is, meaningful innovation of learning through use of digital technologies.

Thus, based on the frameworks of Martin (2009) and Krumsvik (2011), we can say that Estonian schools need digital transformation. Of course, there are good examples of meaningful technology use, but meaningfulness still rather appears to be a challenge in Estonian schools. This is reflected in students' behavioral intention to use digital technologies in different grades. While 6th-graders are more willing to use technologies compared to 3rd-graders, 9th-graders are less interested. This might be explained by the more critical viewpoint of the 9th-grade students: as their further admission to secondary schools depends on their results, the stakes are higher for them when it comes to the learning outcomes and quality of the learning process. Thus, both students and teachers need to learn when and how to use digital technologies meaning fully in the learning process and, even more importantly, when not to use them. The latter is in line with the authors' framework for digital competence, which defines at the level of transformative competence the need to consider other societal goals, such as those related to sustainable development. Every search on the Internet or, even more so, every discussion with AI and creating and training the algorithms for AI requires energy. The amount of energy needed to generate or store one bit of information is not remarkable. However, considering the amount of data recorded in AI systems or video-based technologies, it is clear that we will soon reach the Earth's limits – the matter and energy is limited, and we should not waste it on meaningless activities with digital technologies (Vopson, 2021). However, these discussions have not been explicit in studies capturing Estonian teachers' decision-making processes regarding use of digital learning.

Thus, transformative digital competence seems to be a challenge in Estonia. However, even contextual or generic competence might be challenging sometimes. The DigiEfekt study presents some evidence that contributes to the critical review of the concept of digital natives (Bennet et al., 2008). That is, the new generation of students does not appear to enter the education system with better preparation and high quality technical skills. The DigiEfekt project revealed that students' skills of performing operations required in the digital learning process were rather limited, and their behavior in the digital world often failed to follow the defined rules and restrictions. Thus, it seems that teachers need to be the change agents who guide students towards the meaningful use of digital technologies in the learning process; or, they need to design this meaningful process in collaboration with the students. Otherwise, digital learning might be seen as an academic form of "moral panic," as Bennet et al. (2008) put it when describing the debate around the concept of digital natives. What Bennet and colleagues meant is that the use of sensationalist language that dramatizes differences between generations ends up creating a form of public discourse which does not fairly represent what is happening on the ground. This again highlights the importance of transformative digital competence, which is supposed to guide the moral and ethical use of digital technologies in a sustainable and meaningful way based on a critical analysis and redefinition of the learning goals and activities.

Finally, teachers as change agents in the education system also need to be supported in developing their professional vision of digital teaching and learning. Education strategies, the national curriculum and teacher professional standards provide teachers with general guidelines for applying digital technologies meaningfully. However, these documents do not present details that are needed to change teachers' mindset towards innovative modification and redefinition of the learning activities or defining new goals and replacing some others that were important in the past, but are no longer so. For example, the national curriculum does not specifically focus on digital learning. It only mentions digital competence as a general competence, but this is not operationalized through subject-specific curricula that are guiding teachers' everyday practices. Similarly, teacher professional standards indicate the importance of applying digital technologies and teachers' responsibility for evaluating their own digital competence, but without any details on how to implement the curriculum or digital competence frameworks. Therefore, other measures of change management are necessary. Shulman and Shulman (2004) showed in their framework how teachers' learning is initiated in the interaction of individual and community level variables. In short, according to this framework, teachers learn in communities of practice where they build a shared vision or ideology and develop the knowledge base, but also share commitment and provide support to each other in the community. Thus, digital learning in school could be improved by empowering communities of teachers – or, in broad terms, educators – who can take the lead in transformative innovation towards more meaningful and effective digital learning.

With communities of educators in mind, the Educational Technology master's program was designed at the University of Tartu. The curriculum was developed in line with the principles of entangled pedagogy (Fawns, 2022) by contextualizing digital technologies and the transformation of the teaching and learning practice through digital technologies. It could be expected that a transformation towards more meaningful digital learning is achieved in this shared learning practice, where educators learn from each other by critical reflection and synthesis of their existing practices and theoretical principles of learning sciences. The results presented above show how the learning community has been one of the main benefits of the Educational Technology master's program according to the feedback of the students. What is more, it has had a long-term effect on their mindset and activities they are involved in after graduation. Thus, a similar learning communities oriented approach should be more widely applied in teachers' professional development.

In conclusion, the discussion shows that most of the schools and teachers in Estonia are in the stage of Digitalization according to the framework for digital transformation introduced by Luo and Wee (2021). It means that teachers understand what the affordances of digital technologies are, and optimize their traditional teaching and learning activities by integrating digital technologies; however, there are still several steps to take until the majority of teachers or even teacher communities in schools reach the stage of Digital Transformation. According to the students' and teachers' attitudes, the digital learning process is not meaningful, innovative and student-centered enough to allow the affordances of technologies to have a significant impact on learning outcomes. Furthermore, for some teachers and schools, we might even say that they are still at the stage of Digitization, where methods used in the non-digital learning process are merely slightly enriched with digital technologies.

Thus, the major trends in the context of digital learning in Estonia seem to be the following:

- Digital technologies are actively used in most classes, even if the purposes and ways of their usage are somewhat limited.
- Digital learning is mainly characterized by constructive assignments where students need to integrate their pre-knowledge with new content without any interaction with other learners.
- The digital competence of learners and educators is highlighted as an important general competence in strategic documents.

- There are no major restrictions or impediments that would hinder digital learning in schools: the infrastructure and rules support active integration of digital technologies. Both at school and at home, restrictions are mainly related to the general use of digital devices, but not to their use for learning.
- Teachers' professional development is increasingly organized as an activity of professional communities.

However, these trends are related to several challenges that could be formulated as major issues:

- Schools and teacher communities often lack a clear vision of the meaningful use of digital technologies.
- Teacher shortage is placing higher demands on teachers in terms of coping with the challenges of personalizing learning for students with different needs.
- Strategic documents do not guide teachers towards more specific professional development to improve their contextual and transformative digital competence.
- Students need more guidance towards effective use of digital technologies for learning, including guidance in performing simple operations required in digital learning.
- More research is needed to support digital transformation.

Conclusion

Estonia is a country branded as a "digital education nation." In international comparisons, Estonia is shown to have quite good digital readiness, and the students do remarkably well in achievement tests. Estonian teachers use digital technology actively in the teaching and learning process, and they very often provide students with assignments where they construct new knowledge by synthesizing their pre-knowledge and new material. However, there are also several challenges. For example, the digital learning process could be even more meaningful, supporting collaboration, interaction and better achievement of learning outcomes. In the future, teachers also need to be guided more towards digital transformation; this could be done by empowering teachers' learning communities. A new challenge for the Estonian education system is to critically consider AI use in education – to find a so-called sweet spot where the benefits of digital learning supported by evidence outweigh the cost to the environment. We need to find how meaningful technology use in the learning process could also be sustainable and motivating for both students and teachers, and contribute to solving global challenges, such as sustainable development and the well-being of all people. These challenges should be faced in the collaboration of teachers, teacher educators, researchers, educational technology companies and policy-makers.

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