Trends and Issues of Digital Learning in Sweden

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Abstract

This chapter discusses the trends and issues surrounding digital learning in K-12 schools in Sweden. It begins with an introduction to digital transformation in education and highlights its importance, both in Sweden and also more generally. The focus then shifts specifically to K-12 schools in Sweden and examines the current status of digital learning in this context, explaining the established physical IT infrastructure and broad use of digital tools at all levels of education. The challenges of COVID-19 were a catalyst to implement more goal-oriented activities for teachers and learners. This chapter identifies several trends in digital learning, including the integration of technology into the curriculum, the use of online resources and platforms, the implementation of personalized learning approaches, testbeds, programming and generative AI. It also highlights the challenges and issues associated with digital learning, such as the need for adequate infrastructure, technical support and teacher training, ensuring digital inclusion for all students, and addressing concerns regarding data privacy and security. In conclusion, this chapter emphasizes the need for continued efforts to foster digital learning in K-12 schools in Sweden, while also addressing the associated issues. It suggests that educators and stakeholders should collaborate to provide necessary resources and support for effective digital learning implementation in the classroom.

Keywords: digital learning, digital transformation, Sweden, K-12

Introduction

Structure of the schooling system

The Swedish education system is divided into three main levels: voluntary preschool, compulsory elementary (primary) and lower secondary education, and voluntary upper secondary education[1]. Figure 1 provides a breakdown of the Swedish school system, with a fourth and fifth level concerning adult education. The school system is designed to be comprehensive and democratic, with a strong focus on individual needs and abilities.

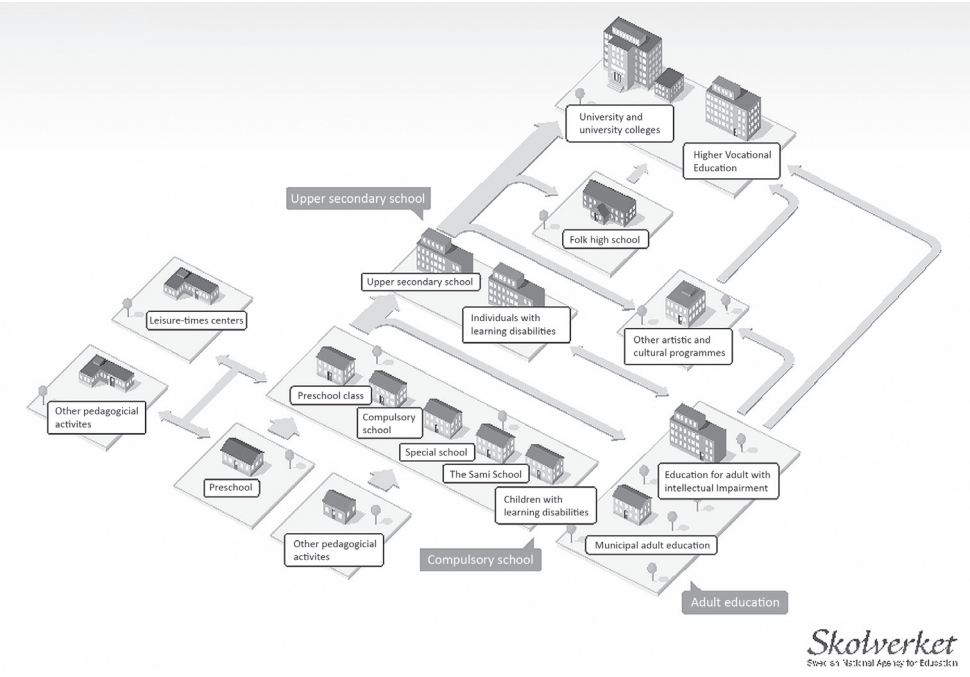
Preschool education is available for children aged 1-5 years old, but is not mandatory. However, most children in Sweden attend preschool. The preschool curriculum aims to provide a safe and stimulating environment for children to learn and develop their social, emotional, and cognitive skills.

Compulsory education (*grundskola*) in Sweden starts at the age of 7 and lasts for 9 years. However, children can start at the age of 6 with a year of voluntary pre-school that introduces them to several curriculum-related subjects. Compulsory education is divided into two stages: elementary school and lower secondary school. Elementary school lasts for 6 years, from the age of 7 to 12, while lower secondary school lasts for 3 years, from the age of 13 to 15. From year 6 and onwards, pupils are awarded grades, with final grades when graduating in year 9. The academic year is divided into one autumn and one spring term. During compulsory education, pupils receive a broad and comprehensive education in a range of subjects, including Swedish, English, Mathematics, Geography, History, Religious knowledge, Civics, Biology, Physics, Chemistry, Technology, Arts, Home Economics, Sport and Health,

1 https://utbildningsguiden.skolverket.se/languages/english-engelska/det-har-arden-svenska-skolan

Music, Textiles, Wood and Metalwork, and a supplementary foreign language.

Figure 1 The Swedish Education System



Note. Figure provided by the Swedish National Agency for Education.

After completing compulsory education, students can choose to continue their education at upper secondary school (gymnasieskola). Upper secondary education is not mandatory, yet most students choose to pursue it. Upper secondary education is divided into 18 national programs, each with its own specialized curriculum. Students choose a program based on their interests and future career aspirations, but grades play a significant role in admission, especially for some of the more favored programs. Upper secondary education usually lasts for 3 years and culminates in a series of final exams. These do not alone determine whether students are eligible for higher education; the composition of different programs, and their respective courses will, together with the final course grades, make up the final result on which students are assessed

for further education. Table 1 presents a breakdown of the number of students and teachers in the major three levels of education (statistics from the Swedish National Agency for Education).

Table 1 A Breakdown of the Total Number of Students and Teachers in the Major Levels of Swedish Schools during the Latest School Year

School Year 2021/2022			
	Compulsory Municipal	Compulsory Independent	Upper Secondary (all forms)
Number of Schools	3,897	828	1295
Number of Students	918,569	178,207	364,431
% Female	48	50	49
% Male	52	50	51
% with a foreign background	27	29	29
Number of Teachers on duty	89,323	16,241	29,905
% Female	68	70	52
% Male	32	30	48

In Sweden, children with learning disabilities attend mandatory special school (*särskolan*) from the ages of seven to sixteen. After the mandatory part, the upper secondary school is also available, but it is optional and offers special national, individual, or special-format programs. For the Sami ethnic group, there are specialized Sami schools available for the first six years of a child's education, after which they can continue their education in regular compulsory basic schools.

Sweden also has a strong tradition of adult education (Vuxenutbildning/*komvux*), with each of the 290 municipalities providing various courses at the compulsory basic and upper secondary school levels. Adult students over the age of 18 take the same subjects and courses as younger students, but at an accelerated pace. Municipal adult education is also available for individuals with

learning disabilities. Newly arrived immigrants who are 16 years of age or older have the right to receive Swedish language education through a Swedish for Immigrants (SFI) program to acquire basic Swedish skills. Additionally, pupils with foreign backgrounds also have the right to education in their native language as a primary school subject, and may work with study materials written in their native language.

The K-12 (Preschool - Post Secondary) school system in Sweden is governed by the state through various means, such as statutes, government orders, curricula, and syllabi. These documents provide direction and guidance for all aspects of education. The municipalities are tasked then with overseeing compulsory and upper secondary education, as well as adult education programs. The Swedish National Agency for Education (Skolverket) serves as the central authority responsible for overseeing the implementation, evaluation, and development of the education system through the Swedish Education Act. The K-12 system of education in Sweden is publicly financed and exempt from fees. In addition, both compulsory and upper secondary school students have the freedom to select their preferred school. For instance, a student who is passionate about music, drama, art, or a specific sport can choose to attend a school with that particular profile. In addition, students can choose also to attend an independent school operated by a non-municipal entity. However, independent schools must be approved by the National Agency for Education and must be accessible to everyone while adhering to the Swedish Education Act. Although independent schools are financially supported by public funds and receive a grant from the municipality for each pupil, they can also impose modest fees at the upper secondary school level. Independent schools often implement specific teaching methods such as Montessori or Waldorf, or can opt to provide only a select number of upper secondary programs. Approximately 3.5% of all Swedish students in compulsory basic school and upper secondary school attend independent schools.

Overall, the Swedish school system is designed to be comprehensive, egalitarian, and focused on individual needs and abilities.

Digital transformation and current stage in K-12 schools

Digital technologies are transforming, among much else in society, the way we provide teaching and learning for a sustainable future. Digital transformation (DX) is a journey of three stages (Luo & Wee, 2021): Stage I - Digitization, conversion of non-digital records to digital format, for example from printed books to digital learning material; Stage II - Digitalization, conversion of processes or interactions into digital equivalents, for example using a mathematics application on a tablet to learn multiplication and division; and Stage III - DX, innovative and disruptive education transformation, for example using educational data analytics to help pedagogical decision making.

DX in education is therefore defined here as *a shift in practices* for school principals, teachers, and students; *an active use of digital tools* in the classroom for teaching and learning and course development; and finally, *a shift even in social forms* through the affordances of digital tools. In education, DX has affected the internal work of organizations and forced the introduction of digital literacy teaching (Dörner & Rundel, 2021), and the development of digital skills and competences (Vuorikari et al., 2022). The COVID-19 pandemic has accelerated the footprint of digital technology in schools and has provided new teaching and learning experiences, as well as a need for change (European Commission, 2020). The pandemic also gave rise to a quick race against the clock to adjust to online pedagogies with all sorts of newly developed digital tools at all levels of education. Some education systems succeeded better than others and were able to set up strategies and continue to provide access to education in spite of the many challenges they faced (OECD, 2020).

Sweden, like many other countries around the world, has recognized the importance of DX in its education system. In 2017, the Swedish government

implemented a national strategy aimed at enhancing the digital competences and skills of both students and teachers in schools (Regeringen, 2017). It entailed competence development for teachers and school leaders, collegial professional learning, appropriate technology, sufficient IT infrastructure and systematic quality improvement work to support equality between schools so that all children and students, as well as staff could develop "adequate" digital competence. As of July 1, 2018, changes were made to the national curriculum for compulsory and upper secondary school levels in response to the strategy, and subsequently also at the preschool level. Children and students were introduced to and now use digital tools in several subjects. For example, children use bots and tablets in preschool to learn basic programming, math and reading skills; digital learning materials covering all school subjects or just individual subjects are used by virtually all students in compulsory schools today. However, the lack of a clear plan on how to approach the transformation has been noted after the publication of the strategy. There have been efforts to provide guidance on areas to focus on for moving forward, such as the #Skoldigiplan report (Sveriges Kommuner och Regioner, 2020). This report however, acknowledged that there is still much work to be done to reach the desired levels of digital capacity. As a matter of fact, the level of DX in Swedish schools covers the whole spectrum: from the use of digital learning materials only, that is, no textbooks are used in all subjects, to individual teachers choosing not to use digital tools for teaching and learning and opting for traditional educational tools instead. Additionally, in December 2022, the Swedish National Agency for Education proposed to the Government a new national digitalization strategy, covering 2023-2027, which the Government sent out for consultation and audit. In May 2023, after the responses came back, the current Minister of Education decided to pause the digitalization strategy. The reason, according to the Minister, is that the strategy does not build on current evidence of brain and child development research in connection to the use of digital technology. Teaching and learning in the classroom should be developed by following clear scientific evidence from this research. Nonetheless, the number of digital

tools for teaching and learning in Swedish schools is extensive, and it is not going to diminish by pausing the digitalization strategy. Sweden has reached a point where access is adequate at all levels of education, fitting Stage III of the DX journey.

The Status of Digital Learning

Contexts of digital learning

One of the most significant changes brought about by DX is the shift from traditional teaching methods to more personalized and student-centered learning. With the help of digital tools such as digital learning materials and online learning platforms, teachers can create customized lesson plans that cater to the individual needs and learning approaches of each student. Learning approaches refer to how students approach academic tasks, such as trying to obtain a holistic picture of what they learn, simply memorizing everything for the exams, or optimizing success in assessment through effective use of time (Masiello, 2005). The different learning approaches afforded by educational technology in the classroom highlight the need to rethink and restructure the learning environment with and around educational technology (Masiello, 2005), therefore, the context of Digital Learning (DL).

DL implementation in K-12 schools

The use of digital tools in Sweden has made learning more interactive and engaging at all levels of education and schools. Students at upper secondary schools use virtual reality (VR) and augmented reality (AR) technologies to explore complex concepts and ideas in a more interactive and immersive way, and with relative contribution to learning (Högström & Holm, 2020). They also use multimedia tools such as videos, animations, and simulations to enhance their understanding of various topics. Children in preschool and compulsory schools use bots and robots to learn programming and computational

thinking (Hamidi et al., 2022; Zerega et al., 2022), or social robots to communicate and speak other languages[2]. DX has also made it easier for schools to collect and analyze data on student performance, both in compulsory and upper secondary education, but especially in higher education (Mohseni et al., Under review). Through online assessments and digital learning materials, teachers can use visualizations of data analysis on student progress, identify areas where students may be struggling, and tailor their teaching accordingly. These data can also be used by school administrators to monitor overall performance and identify areas where improvement is needed, in terms of individual students but also entire classes or schools. The field of data analytics in Sweden is growing mostly within the higher educational setting, with research groups in all Swedish universities (Nouri et al., 2019). Efforts in K-12 education are also relevant, due to the formal DX of the Swedish compulsory education system, although there is still limited research that demonstrates the clear benefits of using data analytics in K-12 educational practice in general (Aguerrebere et al., 2022; Mohseni et al., Under review). More specifically, larger research agencies in Sweden have not provided adequate funding for data analytics research in the compulsory education system (Nouri et al., 2019).

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

Among DL projects/programs, one-to-one computing, where each student is provided with their own computer or tablet, is a popular approach implemented in many schools around the world, including Sweden. Already in 1996, the first one-to-one initiative started in a compulsory school in Färila (Naeslund, 2001). The results were mixed. On the one hand, the students gained digital skills, while on the other hand, the work became monotonous and basic knowledge decreased. The project was stopped. Other similar initia-

2 https://lnu.se/mot-linneuniversitetet/aktuellt/nyheter/2023/skolprojekt-med-roboten-misty/

tives started at larger scales in 2007 and 2010. In one of the larger one-to-one initiatives that took place in 24 municipal compulsory schools, the researchers determined that the computer provided a "more fun" learning environment but also a distraction, and a need for change in teaching (Grönlund, 2014). The same research determined that schools with good results and with highly educated parents could benefit from the introduction of one-to-one computing. While problems with student results became accentuated at schools with lower economic resources and for students whose guardians have only a secondary education (Grönlund, 2014), Swedish schools have nonetheless invested heavily in providing technology to schools, with the aim of improving learning outcomes for students. In 2018, the Swedish National Agency for Education reported that 49% of students in compulsory schools had access to one-to-one computing, up from 16% in 2012, while it was higher for older students in lower and upper secondary classes (Hall et al., 2021). However, the implementation of one-to-one computing also poses challenges for schools, such as ensuring that students use technology in a responsible and safe manner, managing technical issues, and addressing equity concerns related to access to technology. Nevertheless, the use of one-to-one computing in Swedish schools continues to be an important part of the country's DX efforts.

The national strategy introduced by the Government in 2018 affected DL nationwide. The strategy included specific objectives on DL, setting the condition to develop "adequate" digital competence in all children and students through: a) an increased understanding of the impact of DX on society; b) to better be able to use and understand digital tools and media; c) an increased critical and responsible approach; and d) a strengthened ability to solve problems and put ideas into action with the support of digital tools and media. The Swedish National Agency for Education followed up the implementation of the strategy, and more specifically those objectives, with a report (Skolverket, 2022b). The report highlights that teachers, at all levels of education, feel they have sufficient digital knowledge, but they lack programming knowledge and

a critical approach to information on the internet and social media. This means that the objectives are only partially fulfilled, while there is a need for competence development to better achieve the objectives, especially b-d. Those results are also corroborated by research. A study on computer programming in compulsory education grades 4-6 shows that teachers use ad-hoc strategies to facilitate learning, while lacking content knowledge in programming (Bjursten et al., 2022). Similar results were also found with teachers of older students in compulsory schools (Peggar & Shefram, 2020; Vinnervik, 2022). Consequently, there is a risk of inequalities among schools, and that programming will become disorganized or even omitted (Vinnervik, 2023). Research also corroborates the results of the Agency's report in terms of the approach to information and social media, that is, questions related to digital citizenship. In-service and pre-service teachers do not receive the necessary training to tackle the ethical, safe, and sound use of digital technologies or social media (Örtegren, 2022). Again, one consequence is that this can create unequal opportunities for students to develop active citizenship (Olofsson et al., 2020). Therefore, all this emphasizes the implementation gap between the good intentions of the Swedish Government and the reality in schools, calling for teacher preparedness.

The impact of COVID-19 on DL

The COVID-19 pandemic has brought to the fore both benefits and challenges to the DX in Swedish schools, as much as in the rest of the world. On March 19, 2020, a new law gave the government and school principals the ability to temporarily close the premises of educational institutions[3]. This meant that all educational activities were to be carried out online. Through regulatory changes, the government also made it possible for schools to be partially closed, so that only a small number of students could be offered teaching on-site. For example, students could be in school for practical moments, special support,

3 https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/forordning-2020115-om-utbildning-pa_sfs-2020-115/

and examinations. All forms of schools were affected by the change, except for preschools. Later in April, it became possible to apply certain provisions of the regulation on education in the school area and other educational activities in the event of the spread of certain infections, even if the school was open. On May 29, 2020, the Public Health Agency announced that upper secondary schools could reopen from June 15 (Folkhälsomyndigheten, 2020). This meant that upper secondary schools had to quickly adapt from remote teaching to on-site activities, while minimizing the risk of infection for students and staff. On June 9, 2020, the Public Health Agency changed its general recommendations regarding, among other things, personal responsibility in the workplace. For example, staff should have the opportunity to maintain distance, and individuals should avoid public transportation. To prevent students from traveling to school during rush hour on public transport, the government made feasible *hybrid education*, a combination of on-site and remote teaching. This announcement was made on July 16, 2020, and took effect on August 10. The possibility of remote teaching was then extended until June 2021. In short, circumstances changed rapidly, with all the possible consequences imaginable for school staff, students, and guardians.

Shortly after the first case of COVID-19 was confirmed, Swedish organizations, led by the Swedish National Agency for Education, swiftly organized to minimize the negative consequences of the pandemic in the school system. *Skola hemma was launched*[4]. It was a hub for all school staff to find educational material, digital tools, and information from authorities. Many developers of digital content, materials, or tools provided a link to their product free of charge to any school staff who wanted to use their product through the hub. A few days after the hub was launched, upper secondary education and all adult education was to be carried out remotely. The hub initiative made a profound difference and provided support to schools, teachers, and school boards, besides bringing together authorities and organizations which quickly focused

4 https://www.ri.se/en/our-stories/skola-hemma-supporting-learning-at-home

on rapid solutions in an unprecedented time.

Digital learning infrastructure

DL infrastructure in K-12 schools

It must be mentioned that Sweden already had a developed digital infrastructure, and the COVID-19 pandemic simply validated its existence. One-to-one computing is in place in over half of all compulsory and upper secondary schools, while it is possible to loan a computer in all other schools. Tablets are in use in preschools. High-speed internet or wi-fi connections are available in all schools and seem to work with good capacity. However, according to the Swedish Edtech Industry[5], the branch organization that gathers many educational technologies providers, Sweden has no central coordination of basic IT standards, leading to a lack of interoperability between systems, a lack of automated processes, and a lack of secure data analyses and transfer. Additionally, only during the last five years have several activities in terms of digital infrastructures matured[6]. For example, the Swedish EdTech Industry, together with other public and private partners, is currently working on IT standards for a smooth digital ecosystem, a forum for information standards within the school sector, data driven processes in schools, coordination of a national program for competence development of lifelong learning, and an educational technology map (Edtechkartan[7]) intended to help teachers and school principals with the procurement of educational technologies. Moreover, Linnaeus University offers a master's program in Educational Technology[8] (for now only in Swedish) that is meant to give professionals who work in the public or

5 https://swedishedtechindustry.se/standarder/

6 https://swedishedtechindustry.se/digital-infrastruktur-och-it-standarder/

7 https://edtechkartan.se/

8 https://lnu.se/program/utbildningsteknologi-masterprogram/vaxjo-distans-deltid-ht/

private sector the necessary skills to lead the DX in education sectors. Also, the Swedish EdTest[9], a testbed platform, was launched in January 2020 with the aim of improving the digital skills of teachers, developing better digital technologies, and bridging the gap between customers and suppliers by understanding the real needs of the users. Finally, the Swedish National Agency for Education contributes vastly to the digital infrastructure and finances professional development courses for teachers through the universities. The courses span from programming, computational thinking, and digital competences to digital storytelling, critical use of social media, and leading DX. Besides, the Agency offers a large number of online activities and courses and a large repository[10] of subject material readily available for all teachers.

Key statistics and practical examples

The fact that the digital infrastructure is good in Swedish schools can be partially attributed to the vision of the Government that holds that Sweden should be the best in the world in terms of making use of the possibilities of DX in school (Regeringen, 2017). Although, already in the 1980s, the presence of the personal computer had become increasingly common, and many teachers received further training to increase their digital skills. In the 1990s and 2000s, investment in the physical infrastructure, such as wireless network and computers in the classroom, took off (Swedish Edtech Industry, 2020). Processes such as digital attendance reporting, scheduling for teachers and more, were introduced in the 2000s. Statistics from 2021[11] indicate that the cost of K-12 schooling is about 320 billion SEK annually. These costs are covered by municipal taxes, which are approximately 43% of municipalities' total costs. Of these costs, circa 1%, that is, circa 3.7 billion SEK in 2018, is associated

9 https://edtest.se/en

10 https://larportalen.skolverket.se/

11 http://skr.se/skr/skolakulturfritid/forskolagrundochgymnasieskolakomvux/vagledningsvarpavanligafragor/samycketkostarskolan.2785.html

with educational technology investment by Swedish schools (Swedish Edtech Industry, 2020). However, much of the physical infrastructure was built in the 1990s, which suggests that large investments soon need to be made by municipalities to provide uninterrupted DL service in the classroom.

Features of DL

DX also presents some challenges for the Swedish school system. One of the main challenges is the digital divide, where students from low-income families may not have access to the same technology and resources as their peers. This can lead to unequal learning opportunities, and thereby widens the achievement gap. This notion was true before and during the pandemic, and still is. According to van Laar et al. (2017), seven core skills make up digital competence: technical, information management, communication, collaboration, creativity, critical thinking and problem solving. Having these skills means, on the one hand, having the technical skills necessary to use digital technology and services and, on the other hand, having the knowledge necessary to find, analyze and critically evaluate information in different media, that is, media and information literacy. This means that students will need a basic understanding of numeracy and problem solving, as well as literacy, since future careers contributing to a sustainable society will require increased levels of these proficiencies. However, during the last decade, the Swedish school system has been facing challenges in ensuring Quality Education[12] for all students and Reduced Inequalities[13] between students, two of the Sustainable Development Goals of the 2030 Agenda. More specifically, students of linguistic and ethnic minority groups demonstrate lower levels of achievement, both internationally (Denton & West, 2002) and nationally (Skolverket, 2019). An earlier PISA report shows that in Sweden, children born outside the country and refugees perform worse in mathematics than their counterparts in the oth-

12 https://www.globalgoals.org/goals/4-quality-education/

13 https://www.globalgoals.org/goals/10-reduced-inequalities/

er OECD countries (Skolverket, 2010). The reason behind this performance gap could be attributed to less support at home and in the school environment (Skolverket, 2010). A gender bias also exists, where boys outperform girls in mathematical skills, even though the gender gap is decreasing (Skolverket, 2019). Some of the aspects of mathematical knowledge are significant for the development of digital skills such as technical, critical thinking and problem-solving skills. PISA reports also show that students of linguistic and ethnic minority groups demonstrate lower levels of achievement, both internationally and nationally (Skolverket, 2010, 2019). Cultural traditions or socioeconomic conditions at home and in the school environment are once again factors playing a role in the variation of literacy quality (Lundberg, 2005). A gender bias in the opposite direction also exists; in this case girls outperform boys in literacy skills, even though the gender gap is decreasing (Skolverket, 2019). Technological advances are changing our society profoundly, and the heavy use of media allows for new affordances, that is, how we create and respond to information. Research on and development of literacy has been focusing on print and alphabetic literacy, whereas media tools have introduced the need to develop digital literacy (Selfe & Hawisher, 2004). Digital literacy is not solely print-based, but is multimodally varied, and additional aspects, for example, motivation to use online communication, availability and type of resources, convenience of access, availability of support, and possibility of quick feedback are changing the context of learning for learners and educators. As was true for mathematics, some of the aspects of literacy knowledge are also significant for the development of digital competences and literacies, such as information management, communication, collaboration, creativity, and critical thinking[14]. Again, the investment in longitudinal early intervention can help children develop and improve the foundations of the literacy knowledge trajectory in school, especially for students born outside of Sweden.

The COVID-19 pandemic reinforced the challenges in the K-12 school sys-

14 P21.org

tem in Sweden, especially in regard to equality and compensatory mission (Skolverket, 2022a). The measures taken to limit the spread of COVID-19 increased absenteeism among staff and children. The Swedish National Agency for Education assessed that increased staff absences in all forms of school also meant that the quality of teaching was negatively affected in many areas as the teaching could not be carried out as planned, which worsened conditions for the students' knowledge development. The agency suggested that, among other things, the impact seemed to have depended on how much remote teaching the students received, what it looked like in the activities before the switch to remote teaching, and the technical conditions and competence of students and teachers (Skolverket, 2022a). In terms of students, the report suggests that according to teachers and principals, those who, even before the pandemic, had humbler conditions to absorb the teaching, for example students with previously high absenteeism, students in need of support, or students with a mother tongue other than Swedish, did not reach the same levels of knowledge and skills compared to pre-pandemic results. Contrary to many other countries around the world, Sweden kept elementary and lower secondary schools open for the most part, and the fact that a school day could be maintained seems to have had a positive impact on well-being, as well as on knowledge development and social development.

Nevertheless, some difficulties persisted. In terms of teachers, the pandemic only accentuated the challenge for teachers to adapt to new technologies and teaching methods. Some teachers were already resistant to change, or lacked the necessary skills and training to use digital tools effectively, highlighting the need for professional development and training programs (Holmberg, 2023). The pandemic meant that many teachers and other staff had to adjust and manage both new technologies and new teaching methods in a short amount of time. Even though it was exhausting and challenging, new ways of working emerged during the pandemic, which, in some cases, will remain in education in the future, according to principals and teachers (Skolverket,

2022a). Above all, it is about an increased understanding of the possibilities of digitalization and new ways of using digital technology to develop teaching. Teachers state, for example, that they now use learning platforms to a greater extent to create clarity and structure in teaching and as a complement to the other face-to-face teaching in the classroom.

Kreitz-Sandberg et al. (2022) suggested that with regard to an international comparative perspective, the Swedish experience was strongly shaped by the following dimensions:

- A consensus among the government, authorities, and large parts of the political opposition that compulsory schools should have remained open.
- Upper secondary schools basically followed a strategy in the manner of those followed by universities – the hybrid alternative of remote and distance education.
- The relatively smooth transition to remote and distance education during the time of "emergency remote education" was only possible because both teachers and students were already accustomed to using digital tools in the teaching and learning process. Students had access to computers at home, schools had the necessary infrastructure, and teachers had knowledge of how to use computers.

DX has brought about significant changes in the Swedish school system. By leveraging technology, schools could be able to create personalized and engaging learning experiences that cater to the individual needs of each student. However, the digital divide, and the need for ongoing teacher training and professional development remain significant challenges that must be addressed, both in Sweden as elsewhere (European Education and Culture Executive Agency, Eurydice, 2019). Overall, the DX of the Swedish school represents an exciting opportunity to create a more innovative, student-centered, and effective education system.

Trends and Issues in Digital Learning

We conducted a literature search of the latest five years' publications (both in Swedish and English) by Swedish researchers to detect only the most recent and scientific trends and issues in DL.

Trends in DL

Among the trends we find the increasing use of digital technology, personalized learning, testbeds, programming, and generative AI.

Increasing use of digital technology. There has been an increasing trend of the use of digital technology and resources in teaching and learning in Sweden. This includes the use of online platforms, mobile devices, and educational software. According to Larsson and Teigland (2020), digital technologies are readily available and regularly utilized by teachers and students in Swedish schools. Municipalities often justify the adoption of new technologies by emphasizing the importance of aligning education with societal technological advancements. Additionally, they frequently highlight the potential benefits of leveraging these technologies to enhance students' performance. At the same time, the DX of Swedish schools has led to Learning Management Systems (LMS) becoming a prominent work tool within the classroom. This shift, referred to as "platformization," has introduced new practices that impact the daily work of both students and teachers, as LMSs become integrated into everyday school life (Grönlund et al., 2021). For instance, this may result in a loss of certain non-digital learning experiences, such as group work and physical interactions. Striking a balance between technology use and other forms of learning is essential to provide comprehensive education. Establishing a direct correlation between increased access to new technologies, increased utilization, and improved academic performance or grades is challenging. Therefore, while digital technologies can enhance the learning experience, it is important

to ensure that they are used effectively and do not replace traditional methods of teaching and learning.

Focusing on personalized learning. Another trend in DL in Sweden is the focus on personalized learning. Digital tools can be used to create personalized learning experiences that cater to individual student needs and abilities. Research has shown that there has been a significant rise in the adoption of digital game-based learning as an educational tool to enhance pedagogy in Swedish schools (Brooks & Sjöberg, 2022), a form of personalized learning. However, ensuring that digital tools are used to create effective personalized learning experiences is a challenge that is going to be addressed in future research.

Assessing digital learning through testbeds. The global growth of the educational technology sector (also known under the name EdTech) has resulted in a diverse range of products and services, such as learning management systems and AI chatbots. The COVID-19 pandemic further accelerated this growth through increased investments in EdTech companies (HolonIQ, 2021). However, research has shown mixed results regarding the effectiveness of different types of educational technologies (Escueta et al., 2017). Only a small percentage of educational technology innovations have been externally evaluated, indicating that research captures only a fraction of the emerging EdTech sector (Vegas et al., 2019). Continued research is crucial to identify effective EdTech designs and implementation contexts. EdTech Testbeds, popular during the 2010s, assess EdTech effectiveness through co-creation, pilot studies, and randomized controlled studies (Vanbecelaere et al., 2023). Sweden is one of the world leaders in EdTech testbeds. The Swedish Edtest has been successful with over 200 educators and more than 50 EdTech companies participating in the testbed. The Swedish EdTest is brought to the fore as a good example of testbeds on a global scale (Vanbecelaere et al., 2023).

Learning to program. The Swedish national curriculum (Regeringen, 2017)

promotes the development of digital skills within schools. Of those skills, programming and computational thinking are key. Programming by creating digital products was incorporated into the curriculum of Swedish primary and secondary schools in 2017 (Heintz et al., 2017), specifically within the subjects of Mathematics and Technology. The integration of programming and other emerging technologies has been found to present certain difficulties, emphasizing the importance of improved teacher assistance and support (Humble, 2023). According to a study conducted by Vinnervik (2022), which examined the preparedness of Swedish teachers in grades 1 to 9 for integrating programming into Mathematics and Technology courses, it was found that the teachers lacked confidence in their readiness for such implementation. In another study, Peggar and Shefram (2020) confirmed those results and showed that programming is applied only to a limited extent as stated in the curriculum, and teachers reason differently about the programming requirement. Thus, they implement it differently in the classroom. Programming courses for teachers are now offered at most universities in Sweden, and they span from simple block/visual programming to Python language programming. Those courses are very popular.

Making room for generative AI. Generative AI, and what is known as ChatGPT[15], is surely going to be the topic of the decade. Directly after the free introduction of ChatGPT to the internet in November of 2022, the infamous use of the chatbot turned ChatGPT into an instrument for cheating on schoolwork. This vilified use was so rapid that it caught many teachers and school leaders completely unprepared. In Sweden, ChatGPT was used for finding specific answers within the subject of History (Bulduk, 2023), and most probably many others, especially in tertiary education. However, this trend is so contemporary that there is still very little empirical research on this subject. Nonetheless, national magazines[16] and the internet are publishing articles on

15 https://openai.com/blog/chatgpt

16 https://www.dn.se/sverige/ratt-anvand-kan-ai-gora-svensk-skola-battre/

this trend almost daily, with many teachers worried about the fundamentals of their subjects being at risk. The National Agency of Education quickly tried to calm teachers down by providing guidelines on its use in the classroom, advising teachers against the adoption of using homework submissions at all[17]. Once the dust settles, generative AI will probably find its right place in the classroom, helping teachers assess assignments, improving language learning, helping students with special needs, and ultimately augmenting the relationship of human-generative AI.

The education systems of the Nordic countries (Sweden, Denmark, Finland, and Iceland, and Norway) had made significant progress in the last decade, even before the onset of the COVID-19 pandemic. In terms of digital readiness, all five countries are globally recognized for having highly favorable conditions for remote learning (European Commission, 2017; OECD, 2021). Overall, while DL has many benefits, there are also issues that must be addressed to ensure that digital technology is used effectively to support teaching and learning in Sweden.

Issues in DL

DL in K-12 schools in Sweden has also been shaped by the following issues: digital equity; lack of digital skills and training; data security; digital assessment methods; and digital citizenship.

Increasing digital equity for all. This is a major challenge in Sweden. Not all students have equal access to digital devices and internet connectivity at home, which creates a digital divide. For example, during the COVID-19 pandemic, students from disadvantaged backgrounds or rural areas faced difficulties in accessing online resources and participating fully in distance education (Lidegran et al., 2021; Skolverket, 2022a). Within early childhood education,

17 https://www.skolverket.se/undervisning/gymnasieskolan/betyg-i-gymnasieskolan/satta-betyg-i-gymnasieskolan

although creativity, play, and aesthetic work are already emphasized, the integration of technology and emerging materials into preschool education in Sweden remains incomplete. Consequently, a significant portion of the research on technology in early childhood education has concentrated on the utilization of iPads (Landwehr Sydow et al., 2021). Also, in the realm of early childhood education, there is relatively less emphasis placed on teachers and their professional development (Landwehr Sydow et al., 2021). However, efforts are being made by the Swedish National Agency for Education to address this issue by providing equal access to digital resources for all students in the future.

Lacking digital skills and training. Both students and teachers may struggle with limited digital skills and digital literacy skills, hindering their ability to effectively navigate and utilize DL platforms and tools. This can impact the quality of instruction and students' learning outcomes. There have been reports of technology education in lower secondary schools in Sweden deviating from the curriculum, and teachers experiencing widespread uncertainty about how to structure their teaching methods (Fahrman et al., 2020). A study encompassing 131 preschool classrooms in Sweden, Norway, and Finland revealed that even though 82% of the classrooms had multilingual children (many of which were new immigrants), the learning environment did not adequately acknowledge the students' multilingual abilities or the evolving societal trends in digital and multimodal literacy (Hofslundsengen et al., 2020). Moreover, teachers may not receive adequate training or professional development opportunities to effectively integrate technology into their teaching practices. Insufficient technical support and guidance can make it challenging for educators to leverage digital tools to enhance learning experiences, and Swedish researchers have confirmed that to fully leverage digital tools, a shift in teaching mindset is required, as simply providing digital tools alone is insufficient to achieve this objective (Grönlund et al., 2018; Leino Lindell, 2022). In the last few years, the demand for extensive digital technology professional devel-

opment among teachers in schools across Sweden has risen (Forsling, 2019), and, especially after the COVID-19 pandemic, teacher training programs are being developed to address this issue. In the research project the authors have conducted (not yet published), we have been able to demonstrate that with increased digital competence, teachers more often judge substandard digital learning materials and take action. They testify to the uneven quality of the digital learning materials, which in the project can be communicated directly with the EdTech companies for further development. As the digital competence of teachers increases, so do the demands for qualitative digital teaching materials, and their voice is becoming a stronger influencing factor[18].

Ensuring educational data security. Ensuring online safety and protecting students' privacy is crucial in digital learning environments. The risk of cyber threats, data breaches, and inappropriate content poses challenges for schools, requiring robust security measures and strategies to safeguard students' well-being. As an example, the principal of a senior high school in the urban area of Kramfors, emphasizes the importance of addressing the sharing of student data between different stakeholders when it comes to providing personalized support and managing student information (Mattfolk & Emfeldt, 2020). According to him, the most significant challenge today is the ownership and management of student data by two private entities in Sweden. Consequently, the state must expend considerable funds to acquire access to essential data, including personal details such as names, addresses, and guardians. He describes this situation as a significant hindrance since the state does not have complete control over the information required for effective data utilization. As a result, the necessary infrastructure for developing relevant services for teachers, students, and parents is limited. Despite the need to digitize schools, the restricted access to data presents a barrier to innovation in the education sector (Larsson & Teigland, 2020).

18 https://www.smp.se/debatt/forskare-larares-okade-digitala-kompetenser-ger-ovantade-konsekvenser-e0c146c6/

Evaluating learning by digital assessment methods. Evaluating students' progress and understanding can be more complex in online learning. Traditional assessment methods may need to be adapted or replaced with new approaches to effectively assess learning outcomes and ensure fairness in grading. This in turn points to a need to develop new kinds of quality indicators for assessment and grading, for example, regarding digital multimodal text use (Sofkova Hashemi et al., 2020). Previous research conducted by Rönn (2022) demonstrated that within the Swedish school context, which places emphasis on evaluating and grading individual student accomplishments, students have transformed formal assignments into informal and social tasks. The students used various strategies, such as swapping computers, logging into peers' accounts and writing for them, and forwarding pictures with completed assignments. The author concluded that this behavior obscured the intended learning aspect, and hindered teachers' ability to conduct formative assessments effectively. A new aspect that is in every teacher's and student's mind now is the students' use of AI-supported chat robots, such as ChatGPT, to complete written assignments. This has become such an overall predicament that even the National Agency of Education now provides guidelines[19] on its use to teachers.

Teaching digital citizenship. As students spend more and more time online, there is a growing need to teach digital citizenship skills. These include areas such as online safety, digital responsibility, and ethical behavior online. Three Swedish authorities (Swedish Authority for Privacy Protection et al., 2020) have provided a set of guidelines to safeguard and support children and guardians in digital environments. For example, maintaining student engagement and motivation can be more challenging in digital learning environments compared to traditional classroom settings. Distractions, lack of face-to-face interaction, and limited social connections can affect students' participation

19 https://www.skolverket.se/skolutveckling/inspiration-och-stod-i-arbetet/stod-i-arbetet/rad-om-chat-gpt-och-liknande-verktyg

and enthusiasm for learning. On an opposite note, while digital games are a significant aspect of most Swedish youths' lives outside the classroom, their role within educational settings remains relatively unexplored and poorly understood (Mathe et al., 2019).

Addressing these issues requires ongoing efforts from policymakers, educators, and stakeholders to ensure equitable access to technology, provide comprehensive training and support for teachers, foster digital literacy skills among students, and implement appropriate security measures to protect online environments.

Conclusion

The present state of DL in K-12 schools in Sweden is relatively advanced compared to many other countries. The Swedish government has made significant investments in digital infrastructure and equipment for schools, such as computers, tablets, and smartphones. Many schools have adopted platforms to enhance teaching and learning, embracing the DX of education. The three levels of schooling—preschool, compulsory (elementary and lower secondary), and upper secondary—enjoy the use of several national online educational resources that support teaching and learning. These resources provide access to e-books, videos, interactive simulations, and learning materials on many subjects. The Swedish school system is publicly financed, and during the COVID-19 pandemic, the government was also able to provide funding and support for schools to invest in digital technologies and integrate them into teaching and learning through a national hub that offers complete free support and access to otherwise-paid resources.

Sweden has recognized the importance of DX and implemented a national strategy in 2017. The strategy aimed to enhance the digital competences of

students and teachers, resulting in changes to the national curriculum. However, the implementation plan has been lacking, and there is still work to be done to achieve the desired level of digital capacity in Swedish schools. DL in Sweden is characterized by a range of features, including a shift towards personalized, student-centered learning. Through the use of digital tools such as online platforms and learning materials, teachers can create customized lesson plans that cater to each student's individual needs and learning approaches. These tools also make learning more interactive and engaging, with technologies like virtual reality and multimedia enhancing understanding and exploration of complex concepts. DX has also facilitated data collection and analysis, allowing teachers and administrators to track student progress and make informed instructional decisions. Sweden has made significant investments in one-to-one computing, providing students with their own devices, and programming. However, the implementation of digital technologies in schools has presented challenges, such as addressing the digital divide and ensuring responsible and safe technology use. The COVID-19 pandemic further highlighted the benefits and challenges of DX, with remote teaching becoming a necessity. The pandemic also emphasized the importance of supporting teachers in adapting to new technologies and teaching methods.

The authors have identified several trends and issues in DL in Sweden. These trends include an increasing use of digital technology, a focus on personalized learning, research and development actions in the form of EdTech testbeds, programming, and regenerative AI. Digital technology is being widely adopted in Swedish schools, with online platforms, mobile devices, and educational software becoming common tools. However, there is a need to strike a balance between technology use and other forms of learning to ensure comprehensive education. Personalized learning, particularly through digital game-based learning, is also gaining traction but requires further research to optimize its effectiveness. EdTech testbeds, like the Swedish EdTest, have emerged as an effective method for assessing and improving educational technology through

collaboration between educators and EdTech companies. Programming and computational thinking are key components of developing digital skills in schools; however, teachers lack confidence in implementing them. The introduction of generative AI, specifically ChatGPT, has raised concerns due to its initial misuse for cheating on schoolwork; however, as more research and guidelines emerge, generative AI is expected to find a place in the classroom.

Alongside these trends, several issues are shaping DL in Swedish K-12 schools. Digital equity remains a challenge, as not all students have equal access to devices and internet connectivity at home, leading to a digital divide. The lack of digital skills and training among both students and teachers hampers the effective use of DL tools. Data security is a crucial concern, as cyber threats and data breaches pose risks to students' privacy. Furthermore, adapting assessment methods for online learning and teaching digital citizenship skills are additional challenges.

Despite all of this, digital technologies, and their affordances, are extensively used in Swedish schools at all levels, and efforts are being made to provide equal access to technology, offer comprehensive training for teachers, and promote digital literacy skills. The authors' own research project has shown that as the digital competence of teachers increases, so do the demands for qualitative digital teaching materials. Technology and teachers are two sides of the same "school mint." Ongoing collaboration among educators and EdTech companies is crucial to ensure the effective and equitable use of digital technology in Swedish schools.

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