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Digital Downsides in Teacher Education

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Abstract
This paper is particularly relevant in the context of a global pandemic when the majority of teaching is conducted online or in a hybrid environment that requires long hours in front of a screen. Online teaching is becoming increasingly important throughout education, and our findings draw attention to some of the challenges and possible pitfalls of the extensive use of digital technologies and, consequently, implications for teacher education. In the paper, we explore student teachers' perceptions of digital downsides, their teaching tools self-efficacy, their resilience to digital distractions, and physical discomfort from the use of digital technology. We aim to identify these four concepts and examine whether and how they interconnect. A cross-sectional design was used to analyse data from 561 first-year student teachers enrolled in two teacher education programmes in two universities in Norway in 2019. The findings indicate that resilience to digital distractions decreases and a higher level of reported physical discomfort from digital technology increases student teachers' perceived downsides of digital technologies. Overall, 38% of the variation in perceived digital downsides within the two teacher education programmes can be explained by these two concepts, as well as to the study programme the student teachers attended.

Keywords: student teachers, digital downsides, digital distractions, resilience, self-efficacy, physical discomfort

Introduction

The COVID-19 pandemic has occasioned an extended use of online and hybrid teaching in teacher education programmes and education in general. Student teachers face both opportunities and challenges in the ways they use digital technology and how well they are equipped to meet the demands of technology-enhanced teaching and learning. Therefore, it is relevant to investigate how student teachers perceive physical discomfort, resilience to digital distractions, and teaching tools self-efficacy – what may be called the *digital downsides* of using digital technology. Different online portals, learning

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management systems, a variety of digital resources, online lectures, and other forms of organising online teaching, in particular during crises such as the pandemic, are becoming a natural part of university life. Teachers and teacher educators are no longer concerned solely with how to integrate digital technologies in pedagogical practice but also with how to use these technologies in a meaningful way (Beetham & Sharpe, 2020). Scholars and practitioners alike often view the positive potential that specific types of digital technologies bring, and digital technologies are often viewed as an unquestioned "part of the furniture" in universities (Selwyn, 2016, p. 1007). However, limited critical discussion has taken place on the downsides of the technology and how the technology interferes with learning processes and may cause physical discomfort (Binboga & Korhan, 2014; Selwyn, 2016; Lai & Bower, 2019).

In this paper, we focus on the perceived digital downsides of technology reported by student teachers in Norway. The study builds on data collected in an Erasmus+-funded project called Developing ICT in Teacher Education (DICTE, 2019). A model of teachers' digital competence named PEAT has been developed, which consists of four equally important dimensions: the pedagogical dimension (P), an ethical dimension (E), the attitudes of teachers towards the technology (A), and the technology aspect (T) (McGarr & McDonagh, 2019). This paper aims to identify how student teachers perceive digital downsides and to examine how such downsides are related to physical discomfort from the use of digital technology, resilience to digital distractions, and teaching tools self-efficacy. Therefore, our aim ties in with the pedagogical dimension of the PEAT model (aspects of using digital technology at school), the technical aspects (accessing tool competence and the use of technology, which influences physical discomfort), and resilience in digital use, which is connected to the attitudinal and the ethical aspects of the PEAT model. The findings from the data, which were collected before the present COVID-19 pandemic, may signal some of the challenges and possible pitfalls of the extensive use of digital technologies in online teaching, which has recently become the norm. These elements may be experienced during the pandemic in particular but are also bound to characterise teaching and learning practices to a great extent in the future.

Perspectives on Digital Downsides

Rather than critically exploring the digital downsides of the use of digital technology in education, previous studies have often focused on its educational benefits (Badia et al., 2014; Voogt et al., 2013). Furthermore, studies have examined, for example, the efficiency of digital technology in terms of time and cost-effectiveness, the enhancement it offers to teaching and learning processes, learning outcomes, the transformation and profound positive change it brings to existing ways of teaching and learning (HEFCE, 2009). Studies further have looked at how digital technologies are framed within a discourse of improving teaching and learning for the individual or how online platforms and information management systems are necessary to increase efficiency, effectiveness, and service quality and to optimise decision-making (Martins et al., 2019). In addition, many studies take for granted that university students are digital residents and are accustomed to making use of technologies seamlessly and continually in their studies

(Henderson et al., 2017), even though some studies have evidenced the opposite, namely that students lack understanding of digital technologies and cannot be considered as digital natives (Ng, 2012).

Selwyn (2016) introduced four main themes in digital downsides reported by university students. The first theme is *distraction*, that is, the distracting character of digital technology – for example, how social media use takes time away from learning activities. The second theme is *disruption*, namely how digital technology can disrupt teaching when it fails to function and prevents students from learning. The disruption theme also includes lecturers with limited digital competence operating digital tools, which leads to the loss of precious time. The third is what Selwyn (2016) calls *difficulty*, for example, physical aches because of long-term technology use and difficulties related to the design and functionality of the software. Selwyn's fourth and final theme is *detriment,* referring to how technology leads to a lower quality of teaching, which in turn reduces student engagement. For example, the monotonic use of PowerPoint lectures reduces variety and active learning on the part of the students. The present study uses these themes (distraction, disruption, difficulty, and detriment) to discover how student teachers use digital technology and what they perceive as its downsides.

Elements of these themes include how the use of digital technologies can reduce students' focus on schoolwork (distraction), how it stimulates the uncritical copying of online content and can disrupt the unity of the classroom environment (detriment), how it can reduce students' focus on schoolwork (disruption) and how it may cause physical discomfort (difficulty). Studies show how access to and the use of digital technology can create distractions during teaching and learning (Junco & Cotton, 2012; Langford et al., 2016). Many studies are concerned with academic misconduct – that is, how the uncritical reuse of others' online content is becoming a standard practice for students in higher education (Georgiadou et al., 2018) – although some studies report less misconduct in online courses than in face-to-face courses (Peled et al., 2017). In the same vein, other works have explored how students cannot evaluate and understand online information and distinguish between facts and fake news – in other words, critical literacy (Musgrove et al., 2017; Frønes, 2017) – and avoid cyber-plagiarism in general (Chang et al., 2015). Finally, certain studies have questioned the position digital technology is gaining in the classroom and how digital devices are creating both physical and cognitive barriers between students and teachers. This is particularly relevant in the context of COVID-19, where many classrooms have moved from physical spaces to online environments (Hartshorne et al., 2020; Gudmundsdottir & Hathaway, 2020). Moreover, students are distracted by multitasking, which may involve checking e-mails, chatting, and online shopping while attending classes (Langford et al., 2016), thus disrupting the unity of the classroom.

Physical Discomfort when Using Digital Technology

Physical discomfort in the present context can be understood as physical aches and pains related to the use of computers, laptops, tablets, and other digital technologies (Palmer et al., 2014). This discomfort may arise from awkward or unsuitable sitting or working positions and exposure to screens and handheld devices. Adolescents in education have reported pain in the shoulders and the neck and headaches in Sweden (Palm et al., 2007) and South Africa (Smith et al., 2008) related to the use of digital technology. Similarly, employees have reported physical discomfort from using digital technology in their work (Ciccarelli et al., 2012).

A common feature of physical discomfort and digital downsides is that both concepts imply negative aspects of digital technologies. Experiencing physical discomfort could explain why some students are more sceptical of using digital technology in teaching and learning. Therefore, we assume that physical discomfort may be related to perceived digital downsides.

> **Hypothesis 1 (H1)**: Student teachers with higher levels of physical discomfort are more likely to report higher levels of digital downsides.

Resilience to Digital Distractions

Resilience to digital distractions is about resisting or avoiding digital temptations and disturbances that lead the student away from learning. There are various ways to understand this concept. One way is to view it at a system-level and investigate the capacity of education systems to absorb disturbance to retain both function and identity (Weller & Anderson, 2013; Hopkins, 2009). Students may experience digital technology as a time thief (Henderson et al., 2017). Thus, resilience to digital distractions can be related to the control aspects of self-discipline (Christophersen et al., 2017) and self-regulated learning (Panadero & Alonso, 2014). In this context, a more general concept of resilience as "the qualities of both the individual and the individual's environment that potentiate positive development" comes to mind (Ungar & Liebenberg, 2011, p. 127). However, in the present paper, resilience to digital distraction is applied on an individual level (Simons et al., 2018), as young people reportedly encounter challenges in dealing with digital downsides (Henderson et al., 2017; Selwyn, 2016). In the realm of initial teacher education, resilience to digital distractions can help teacher educators understand how student teachers perceive their own control when using digital technology.

Overall, it seems important that student teachers learn how to avoid the downsides of digital technology (Goundar, 2014; Selwyn, 2016) and how to cope with and absorb disturbances during teaching (Simons et al., 2018). Therefore, we expect that student teachers who exhibit resilience to digital use are also willing to highlight the benefits of technology and not emphasise the digital downsides. Our second assumption is that resilience to digital distractions may be related to digital downsides.

> **Hypothesis 2 (H2):** Student teachers with higher levels of resilience to digital distractions are more likely to report lower levels of digital downsides.

Teaching Tools Self-efficacy

The concept of teaching tools self-efficacy is developed from the theory of self-efficacy (Bandura, 1997, 2015). Several research studies have emphasised that self-efficacy is positively associated with teachers' development (Skaalvik & Skaalvik, 2017), occupational commitment (Klassen et al., 2013), perceived successful teaching practices (Klassen & Tze, 2014), perspectives on career (McLennan et al., 2017) and job satisfaction (Aldrige & Fraser, 2016).

There are various ways to clarify and comprehend the concept of teaching tools self-efficacy, which essentially means confidence in using tools for teaching. We have chosen an approach based on a specific topic, as it contributes to practical and authentic use of the concept (Bandura, 2015; Klassen & Chiu, 2010). Although not all student teachers have their own experiences with digital teaching tools, they can develop experiences by observing or following others (i.e. school teachers or student teachers). This means that knowing that other student teachers have successful experiences with teaching tools can contribute to developing one's own teaching tools self-efficacy (Wallace, 2017, p. 26).

We, therefore, expect that confident student teachers can see the benefits – rather than the downsides – of digital technology. Our third assumption is that teaching tools' self-efficacy may be related to digital downsides.

> **Hypothesis 3 (H3)**: Student teachers with higher levels of teaching tools self-efficacy are more likely to report lower levels of digital downsides.

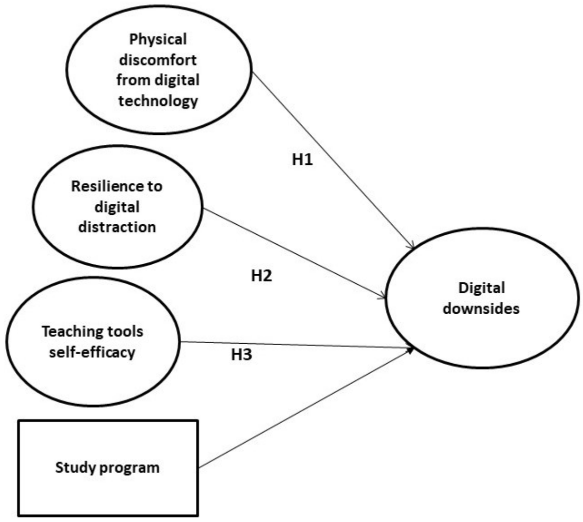
The Present Study

This present study attempts to fill the gap in research on the downsides of digital technology, identified for example by Badia et al. (2014), Lai and Bower (2019), and Voogt et al. (2013). It also considers how digital technologies are often taken for granted as a means of facilitating teaching and learning at universities (Henderson et al., 2017), although some findings indicate that there are negative experiences such as physical discomfort connected with the use of digital technologies in higher education (Selwyn, 2016). Our first research question is, therefore: *How do student teachers experience digital downsides in education and physical discomfort from using digital technology?*

In contrast to these negative aspects, certain topics can help explain positive experiences with digital technologies. Resilience to digital distractions and teaching tools self-efficacy are relevant themes here, leading to our second research question: *How do student teachers experience resilience to digital distractions and teaching tools self-efficacy?*

Finally, this paper also attempts to explain the variations in how student teachers perceive digital downsides by asking: *To what extent can physical discomfort, resilience to digital distractions, and teaching tools self-efficacy explain student teachers' perceived digital downsides?* These three research questions relate to hypotheses H1, H2, and H3 and are illustrated with arrows in Figure 1.

Figure 1. Model illustrating how the variables can explain variation in digital downsides when controlled for the study programme.



Method

Contextual Background: The Case of Norway

The focus of this study was student teachers attending teacher education programmes in two universities in urban Norway. In Norway, digital competence has been high on the political agenda for two decades. The Norwegian curriculum reform of 2006 (LK06) first introduced the pupils' basic skills framework. This framework includes five basic skills: reading, writing, numeracy, oral skills, and digital skills (Norwegian Directorate for Education and Training, 2012). These basic skills are to be integrated into all subjects from grades 1 to 13. In 2012, the Norwegian Directorate for Education and Training revised its basic skills framework, and it became a clearer part of subject curricula, competence aims, and expected learning outcomes. The curricula require that teachers utilise digital tools in their teaching, foster pupils' digital skills, and integrate these skills into subject knowledge. Since all pupils should be given an opportunity to develop basic skills during their primary and secondary education, student teachers in teacher education programmes also need to have basic digital competence to be able to assist their pupils in searching for and processing information, producing and communicating online and exercising digital responsibility. The latest curriculum reform (LK20) also emphasises digital citizenship in social science and computational thinking within mathematics as important competencies in pupils' learning. Thus, several policy documents, national guidelines, and steering documents stipulate the expectations of teachers and teacher education and the use of digital technology.

Teacher education in Norway consists of a five-year master's programme, with student teachers being granted a professional degree upon completion of their course. The curriculum for teacher education in Norway offers teaching qualifications and competence in subjects, subject didactics, and pedagogy. The master's programme is divided into three levels: primary school teacher (grades 1–7), primary and lower secondary teacher (grades 5–10), and secondary school teacher for grades 8–13 (upper secondary).

In the national guidelines for teacher education in grades 1–7 and 5–10, learning outcomes are divided into knowledge, skills, and general competence, digital skills being explicitly mentioned. In the guidelines for teacher education for primary and lower secondary schools, student teachers are required to learn how to develop pupils' digital competence. Moreover, student teachers for grades 5–10 are supposed to learn about the general and cultural development of children, including in digital contexts. As digital skills are a part of basic skills in all subjects and grades, subject teachers are responsible for integrating digital aspects in their teaching across the board. Moreover, the national guidelines for teacher education in grades 8–13 include a particular section on teachers' professional digital competence (PDC) (Brevik et al., 2019). PDC is developed across seven competence areas (Kelentrić et al., 2017) and includes general digital competence, subject-related digital competence, and professional digital competence (Gudmundsdottir & Hatlevik, 2018). In all three levels in the teacher education programme, it is emphasised that student teachers must incorporate digital skills in both teaching and assessment activities on campus and their practical training in schools.

Sample

All first-year student teachers at the faculties of education in two universities in Norway were invited to participate in an online survey on their perceived digital competence. First-year student teachers were chosen to discover what characterises them when they enter teacher education, specifically whether they have already experienced physical discomfort from using digital technology, to be able to conduct follow-up research later in their study programmes. Ethical approval for the survey was received in advance from the Norwegian Centre for Research Data.

The survey was conducted during autumn 2019, and the participating student teachers came from all three groups according to the level at which they were training to teach. At one of the universities, the student teachers were able to take the survey in small groups of about 20–30 students, in connection with obligatory classes. At the other university, the student teachers received a link to the survey in an introductory lecture. All student teachers who attended this lecture had 15 minutes at the end of the lecture to complete the survey. Although the student teachers were encouraged to participate in the study, they could withdraw at any time, as participation was voluntary. In total, 561 first-year student teachers answered the survey. Among the students who attended the lecture, there was a response rate of over 80%.

Instruments

A self-report questionnaire was developed to measure the following four concepts: perceived digital downsides, resilience to digital distractions, teaching tools self-efficacy, and perceived physical discomfort from using digital technology (see the complete statements in Table 2). The initial response categories for all items were: *1 = Totally* *disagree*, *2 = Partly disagree*, *3 = Neither agree nor disagree*, *4 = Partly agree* and *5 = Totally agree*.

Digital downsides. The student teachers were asked to respond to three statements about the use of digital technology in schools: whether it leads to reduced focus on schoolwork, whether it leads to the uncritical copying of content from the internet and whether it disrupts the unity of the classroom. The scale was adapted from a national ICT monitor study (Hatlevik et al., 2013).

Perceived physical discomfort from digital technology. The student teachers were asked to respond to three statements about the physical consequences of using computers, tablets, or mobile devices: sore eyes, pain in the arms and shoulders, and headache. The statements were adapted from a previous study (Scherer & Hatlevik, 2017).

Resilience to digital distractions. The student teachers were also asked to respond to four statements about their experiences with the use of computers, tablets, or mobile phones: whether they steal time that could have been spent understanding a topic, disturb the participants from learning subjects, prolong schoolwork and derail student teachers from schoolwork. The statements were inspired by a study by Sørebø et al. (2009). After data collection, the scale (from *Totally disagree* to *Totally agree*) was reversed so that positive responses corresponded to higher values in the analysis. This meant that higher values corresponded to and could be interpreted as higher levels of resilience to digital distractions.

Teaching tools self-efficacy. The student teachers were asked to respond to four statements about their own capabilities to successfully use teaching tools: tools for interactive whiteboards, for creating graphical representations, for learning games, and student response systems. The scale was adapted from a national ICT monitor study (Hatlevik et al., 2013).

Analytical approach

Research questions 1 and 2 were answered in two steps. In the initial step, the four concepts were examined and identified through structural equation modelling (SEM). Next, the frequency of agreement on the statements, together with the mean scores of the items, were used to investigate to what extent the student teachers agreed or disagreed with the statements.

Research question 3 and the three hypotheses were tested with SEM of a path model (Brown, 2006). SEM gave us the option to combine confirmatory factor analysis of the four factors with a test of how the factors, together with the study programme, could explain the variation in perceived digital downsides. In addition to the levels of factor loadings, we scrutinised four indices to evaluate how well the associations described in Figure 1 fitted the data. We assumed acceptable levels of the comparative fit index (CFI) and the Tucker–Lewis fit index (TLI) to be above 0.90 and those of the root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR) to be below 0.08 and 0.06, respectively (Hu & Bentler, 1999; Brown, 2006). The assumed cut-off levels for the factor loadings were 0.32 (poor), 0.45 (fair), 0.55 (good), 0.63 (very good) or 0.71 (excellent) (Tabachnick & Fidell, 2007, p. 649).

The Sample and Properties of the Items

In total, 561 student teachers participated in the study, of whom 66% were female. Of the total, 40% were 20 years old or younger and 50% were between 21 and 25 years old (see Table 1); 34% of the student teachers were enrolled in the study programme for teaching in grades 1–7, 30% for teaching in grades 5–10 and 36% for teaching in grades 8–13.

Table 1. Gender, age, and number of participating student teachers

	Study programme 1–7	**Study programme 5–10**	**Study programme 8–13**
Gender	80% females	57% females	61% females
Age (20 years or less)	44%	38%	38%
Age (21–25 years)	48%	49%	56%
No. of student teachers	189	172	200

Results

Descriptive Findings on the Item Level

The answers about digital downsides showed that 22% of the subjects thought that the use of digital technology can reduce focus on schoolwork, 26% agreed that it reduces unity and the notion of belonging in the class and 49% agreed that it leads to uncritical copying of content. Regarding physical discomfort, 30% agreed that the use of digital technology leads to sore eyes, 28% reported getting a headache and 22% said that they get pain in the shoulders and arms (see Table 2).

The answers to the questions related to resilience to digital distractions showed that 47% of the student teachers did not perceive that digital technology prolongs their schoolwork, 28% resisted disturbances when learning a subject, 23% reported it is not a time thief and 20% disagreed that schoolwork is derailed. When it came to teaching tool self-efficacy, 78% reported good competence using student response systems, 47% using games, 46% generating digital representations, and 23% using interactive whiteboards. Table 2 shows the values for the mean, standard error, percentage “agree”, skewness, kurtosis, and factor loadings for all items.

Psychometric Properties: Examining the Research Questions by Testing the Model

All three hypotheses in Figure 1 can be illustrated through testing the factor analysis and associations in Figure 1. The model converged to a good solution: Chi-square (χ^2) = 161.98, degrees of freedom = 84 ($p > .05$) and $N = 561$. Further, CFI = .969, TLI = .961, RMSEA = .041 (LO 90 = .031 and HI = .050) and SRMR = .042.

Table 2. Means (M), standard error (SE), percentage agreement (% agree), skewness, kurtosis and factor loadings for all items of the administered scales. Data from Mplus (Chi-square (χ^2) = 161.98, degrees of freedom = 84 (p > .05) and N = 561. Furthermore, CFI = 0.969, TLI = 0.961, RMSEA = 0.041 (LO 90 = 0.031 and HI = 0.050) and SRMR = 0.042.

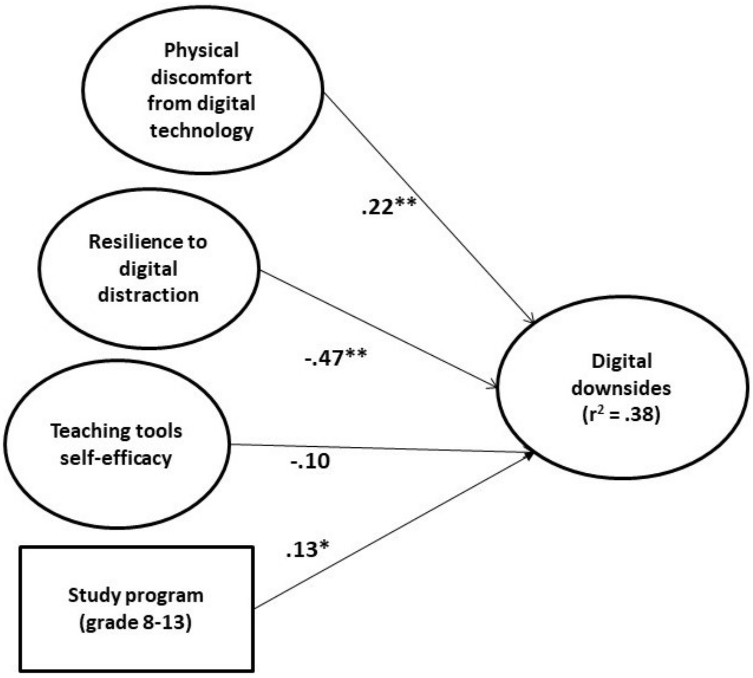
Scale Items	M (SE)	% agree	Skewness	Kurtosis	Factor loadings (SE)
Digital downsides (Cronbach's α = .61)					
The use of ICT in teaching at school:					
Leads to reduced focus on schoolwork	2.89 (0.04)	22%	.10	-.12	.65 (.04)**
Leads to the uncritical copying of content from the internet	3.43 (0.04)	49%	-.42	.27	.50 (.04)**
Disrupts the unity of the classroom	3.01 (0.04)	26%	-.05	.07	.63 (.04)**
Physical discomfort from digital technology (Cronbach's α = .78)					
The use of computers, tablets and cellphones:					
Causes sore eyes	2.77 (0.05)	30%	-.09	-.94	.79 (.03)**
Causes me to have a headache	2.70 (0.05)	28%	-.05	-.96	.83 (.03)**
Causes pain in my arms and shoulders	2.57 (0.05)	22%	.29	-.77	.61 (.03)**
Resilience in digital use (Cronbach's α = .84)					
The use of computers, tablets and cellphones (recoded):					
Steals [NOT] the time I could have spent understanding a topic	2.74 (0.04)	23%	.13	-.56	.77 (.02)**
Disturbs me [NOT] in learning subjects	2.90 (0.04)	28%	-.02	-.56	.89 (.02)**
Prolongs [NOT] schoolwork	3.37 (0.04)	47%	-.22	-.42	.59 (.03)**
Derails me [NOT] from schoolwork	2.73 (0.04)	20%	.33	-.29	.76 (.02)**
Teaching tools self-efficacy (Cronbach's α = .77)					
Assess your own competence in using:					
Tools for interactive whiteboards	2.90 (0.04)	23%	.06	.01	.70 (.03)**
Tools for creating graphical representations	3.30 (0.04)	46%	-.29	-.49	.56 (.04)**
Learning games	3.41 (0.04)	47%	-.35	.11	.82 (.03)**
Student response systems	4.10 (0.03)	78%	-.68	-.34	.66 (.03)**

Note: ** $p < .01$

Based on the results from the SEM analysis, it seems that we are dealing with four distinct concepts. Concerning the four factors, 13 of 14 factor loadings are above the cut-off score (.55) for good factor loadings (Tabachnick et al., 2007). The factor loading for "Leads to reduced focus on schoolwork" was .50, which is above fair but below good. One recommendation is to improve this item for future studies.

Overall, the results from the SEM (Figure 2) show a positive relationship between physical discomfort and digital downsides ($r = .22$, $p < .01$), a negative relationship between resilience to digital distractions and digital downsides ($r = -0.41$, $p < .01$) and a negative relationship between teaching tools self-efficacy and digital downsides ($r = -0.10$, not significant). Finally, the latent variables in the model explain 38% of the variation in digital downsides. In addition, student teachers enrolled in the study programme for grades 8–13 were more concerned with the digital downsides of technology use than those enrolled in the other study programmes.

*Figure 2. Tested model with regression coefficients and explained variation in the dependent variables (**p < .01).*



Discussion

This paper investigates the relationship between student teachers' perceived digital downsides, physical discomfort, resilience to digital distractions, and teaching tools self-efficacy.

Concerning the first research question on how student teachers experience digital downsides in education and physical discomfort from digital technology, almost half of the participants agreed that access to digital technologies leads to uncritical copying of content. This is in line with another study showing that it is perceived as easy to copy text rather than critically evaluate and rewrite text (Kauffman & Young, 2015). However, it is possible to develop training programmes that raise students' awareness of how to exercise source criticism and avoid uncritical copying of content (Kauffman & Young, 2015). Access to digital technologies in schools is a part of the classroom environment and is also important for student teachers' learning and study strategies. However, when digital technologies become a prominent part of education, they can also lead to both greater physical discomfort, owing to long hours in front of the screen, and disruption of unity in the classroom environment. The findings coincide with previous research from other workplaces (Ciccarelli et al., 2012), showing that about one in four student teachers has experienced physical aches caused by using digital technology. The student teachers in the present study experienced headache and pain in the arms and shoulders and agreed that sore eyes can be an issue, which indicates the relevance of exploring a greater variety in work methods and considering shorter sessions in front of a screen. One practical lesson from the study may be that teacher education helps students build sustainable work habits with digital technology to avoid physical discomfort in the future.

In addition, the unity of the classroom needs to be considered when using online platforms extensively (Henderson et al., 2017). Active learning, online interaction, and cooperative learning can all influence the notion of belonging (Selwyn, 2016). Group work and cooperation can generate a greater feeling of unity in the class and positively contribute to a better classroom environment. The digital downside of reduced focus on schoolwork is something we also find in our data material, and approximately one in five student teachers was concerned about this aspect. All the elements mentioned above also play a role in how to ensure good practices, which can reduce the downsides of digital technology use by preventing physical discomfort and boosting unity, focusing on schoolwork, and the critical use of online resources among student teachers. In teacher education, testing prototypes or different models of the best or next practices in the use of digital technology is recommended.

Concerning the second research question and how the student teachers experience resilience to digital distractions and teaching tools self-efficacy, it seems that a smaller number of student teachers report that digital technologies disturb their learning (28%) and are perceived as a time thief (20%). A somewhat larger share of student teachers believe that digital technologies prolong their learning processes (47%). This finding emphasises the importance of linking digital technologies to a teaching and learning purpose, which is in line with Selwyn's (2016) point that digital technologies can be considered part of the learning environment, whether or not there is an awareness or plan on how such technologies should contribute to students' learning outcomes.

The data also show that student teachers perceive that teaching tools' self-efficacy varies greatly across tasks or technologies. A smaller proportion of participants reported the successful use of interactive whiteboards compared to the fraction who believed they had mastered the use of student response systems. The great variation in student teachers' tools self-efficacy may also vary with the availability of digital tools in various settings – for example, in individual schools or if the tools are used actively within the teacher education programme. It is not a given that young people are digital natives (Ng, 2012) and their competence levels vary. Our findings show that student teachers report higher levels of teaching tools self-efficacy in some topics than in others. A suggestion is therefore to set aside time and resources so that student teachers can be trained in using a variety of digital tools as part of their professional development.

Regarding the third research question on the extent to which physical discomfort, resilience to digital distractions, and teaching tools self-efficacy can explain variations in student teachers' perceived digital downsides (Figure 1), the experience of physical discomfort was found to have a positive association with a perception of the downsides of digital technology (supporting H1). One explanation may be that both concepts imply a negative understanding or perception of digital technologies. Moreover, those who exhibit resilience to digital distractions report experiencing the disadvantages of digital technologies to a lesser extent (supporting H2). It is surely important to gain more knowledge about how to develop resilience and how teacher education can contribute to student teachers' ability to convey this in their teaching practice.

We expected to find that the less confident student teachers would report higher levels of digital downsides compared with the more confident student teachers (H3). However, there is no significant association between what the participants reported about their teaching tools self-efficacy and their perceived digital downsides (thereby rejecting H3). One explanation could be that the components of teaching tools self-efficacy involve assessing one's competence, whereas the components of digital downsides represent how digital technologies work for a group or class of students. This means that, although student teachers may feel they have general mastery of digital technology, using the technology in their teaching practice can still be challenging.

Conclusion and Further Research

This study set out to identify how student teachers perceived digital downsides and what they reported on their teaching tools self-efficacy, resilience to digital distractions, and perceived physical discomfort from the use of digital technology. The study aimed to examine these four concepts and how they interconnect. As discussed above, student teachers face both opportunities and challenges in the way they use digital technology and how they are equipped to deliver technology-enhanced teaching and learning. The most obvious finding of this study is that resistance to digital distractions and the levels of physical discomfort reported by the participants appear to be associated with the perceived digital downsides. Resistance to digital distractions has a negative association and physical discomfort has a positive association with digital downsides. Nevertheless, the concept of self-efficacy needs further elaboration to identify how it can improve understanding of student teachers' approaches to digital downsides. A limitation of the study is that it did not take into consideration whether the student teachers who desired less screen time were in any way suffering economic difficulties, just one of the underlying challenges that student teachers may face. This is worthy of further exploration in future studies.

Summing up, the implications of our findings suggest the importance of resilience to digital distractions and of including it in teacher education programmes. Further, to support student teachers who experience digital downsides and a lack of digital resilience, it is recommended that teacher education programmes put a stronger emphasis on including aspects of digital responsibility in their courses. This would also link nicely to the PEAT model (DICTE, 2019), in particular the pedagogical and ethical dimensions, when developing student teachers' digital competence. Finally, the development of teachers' professional digital competence is particularly relevant when most of the teaching takes place online or in a hybrid environment that requires long hours in front of a screen. Overall, our results provide insight into the challenges and potential obstacles that the extensive use of digital technologies may bring.

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