Computers & Education 115 (2017) 188–200

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

"Sore eyes and distracted" or "excited and confident"? – The role of perceived negative consequences of using ICT for perceived usefulness and self-efficacy

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A R T I C L E I N F O

Article history:
Received 12 December 2016
Received in revised form 8 August 2017
Accepted 15 August 2017
Available online 16 August 2017

Keywords:
Discomfort from using ICT
Distraction
ICT self-efficacy
ICT use
Perceived usefulness

A B S T R A C T

Many adolescents feel confident about using information and communication technology (ICT) and believe that it can help them to learn and achieve. However, recent research also shows that some adolescents are reporting physical discomfort from using ICT such as sore eyes and pain in neck and shoulders. This paper explores how primary school students perceive the negative consequences of using ICT (i.e., discomfort and distraction) in relation to the use of ICT for school and leisure purposes, their self-beliefs, and the perceived usefulness of ICT. Using the data obtained from a large sample of Norwegian seventh-graders ($N = 1{,}640$, between 12 and 13 years old), we performed structural equation modelling to test our assumptions on the role of students' discomfort from using ICT. We hypothesized an indirect effects model, in which the use of ICT and students' beliefs are indirectly associated via perceived discomfort. Our findings are two-fold: First, discomfort from using ICT was negatively related to students' use of ICT for leisure; yet neither to self-efficacy in using ICT nor perceived usefulness. In contrast, perceived distraction by ICT was negatively related to perceived usefulness, yet positively associated with ICT use in lessons. Second, the direct and positive relations among the use of ICT, perceived usefulness, and self-efficacy were statistically significant. These findings uncover that the potentially negative consequences of distraction relate to the extent to which students perceive ICT as useful.

1. Introduction

The relevance of information and communication technology (ICT) has permeated adolescents' lives in many ways. In fact, they are using ICT not only for leisure activities outside of school (e.g., social networking, gaming, listening to music, or watching movies) but also for school-related activities (e.g., writing texts, making a presentation, or submitting an assignment). Recent international research indicates that, on average across OECD countries, students use ICT at least an hour each

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http://dx.doi.org/10.1016/j.compedu.2017.08.003

day, and recognizes that frequent Internet use may have negative effects on educational outcomes such as school achievement (OECD, 2015). Of course, the frequencies of using ICT at home and in school differ largely with more hours per week spent on ICT at home (e.g., Eurydice, 2011; Wastiau, Blamire, Kearney, & Quittre, 2014). Consequently, researchers have begun to explore the effects of frequent ICT use on school-related outcomes and students' health (e.g., Bowers & Berland, 2013; Cheung & Slavin, 2013; Nuutinen et al., 2014).

Coleman, Straker, and Ciccarelli (2009) examined the extent to which children experienced discomfort due to daily activities such as computer use, watching TV, gaming, reading, and physical activities and found that discomfort was most often considered to be a result of using electronic media extensively. Moreover, Coleman et al. (2009) identified students' beliefs about potential causes and solutions to the experienced discomfort and showed that they developed beliefs that are based on scientific knowledge of the potential risks of extensive activities. Palmer, Cicarelli, Falmer, and Parsons (2014) further reported results from a survey with adolescents and uncovered that most students had experienced sore eyes, neck pain, or pain in their shoulders from using ICT. However, the authors did not find any statistically significant correlation between perceived discomfort and the use of ICT. This observation might indicate that either discomfort is not widespread or a relatively new phenomenon and that the awareness of students' discomfort from using ICT is limited. Nevertheless, with increased use of computers in the classroom, physical ailments become a growing problem in schools (Zlamanski & Ciccarelli, 2012). Dockrell, Earle, and Galvin (2010) points out that there is still very limited research in this area, and further studies about the potentially *negative* experiences from using ICT are needed.

Traditionally, there have been many studies on the positive results from ICT use, e.g., positive relations to mathematics achievements in K-12 (Cheung & Slavin, 2013), to academic achievements in several subjects in K-12 (Zheng, Warshauer, Lin, & Chang, 2016), and that ICT has a medium effect on the learning outcomes in elementary school (Chauhan, 2017). However, at the same time, this perspective on the results of ICT use is rather narrow and needs to be balanced by considering both positive and negative results from ICT use. Two of the most prominent concepts describing the negative consequences of ICT use refer to students' discomfort and distraction. Whereas discomfort includes physical pain and psychological imbalance that are caused by the use of ICT (Palmer et al., 2014), distraction describes a state in which ICT prevents students from focusing on other relevant tasks (Campbell & Henning, 2010).

Perceived usefulness and ICT self-efficacy are concepts looking at the students' beliefs about the perceived benefits from using ICT. Several studies are taking these perspectives, ICT self-efficacy (Krumsvik, 2011; Rohatgi, Scherer, & Hatlevik, 2016) and perceived usefulness of ICT (Edmunds, Thorpe, & Conole, 2012; Lau & Yuen, 2014) when investigating students' use of ICT. However, until now few studies have attempted to nuance the picture, combing the measure of perceived usefulness and ICT self-efficacy to students' perceived distraction and experienced discomfort from using ICT. The present study consequently examines perceived negative consequences of using ICT (i.e., discomfort and distraction) in relation to their (a) use of ICT, (b) perceived usefulness of ICT, and (c) ICT self-efficacy.

1.1. Perspectives

Langford, Narayan, and von Glahn (2016) point out that digital technology in schools and classrooms is a controversial topic. This introduction part shows how important it is to consider the research on students' experience of perceived negative consequences of ICT and the more positive outcomes of ICT. We start by reviewing research about discomfort form using ICT.

1.2. Discomfort from using ICT

Discomfort from using ICT can be defined as students' experiences of physical pain or psychological imbalance related to their use of digital technologies such as computer, laptop or tablets (Palmer et al., 2014). Ciccarelli, Portsmouth, Harris, and Jacobs (2012) present recent research from workplaces that shows that adults report discomfort from using ICT. Discomfort at work can be attributed to frequent and prolonged exposure in front of screens and awkward sitting positions due to poor furniture and how the workplace is organized (Ciccarelli et al., 2012). Palm et al. (2007) found that headaches, neck pain, or pain in the shoulders are common among Swedish 16-18-year-olds students. They reported higher levels of discomfort among the high frequent ICT users compared with the less frequent ICT users. This finding has been supported by a study from Smith, Louw, Crous, and Grimmer-Somers (2008) for a South-African sample. The authors demonstrated a significant connection between headaches and neck pain and the number of hours spent in front of a computer. Furthermore, Dockrell et al. (2010) studied physical ailments using computers in primary school and consequently concluded that research should be more concerned about the negative physical effects that affect children using computer in school.

Another approach describing the negative consequences of ICT is the recent research on distraction from using ICT in education (Langford et al., 2016).

1.3. Perceived distraction by ICT

As mentioned above, the concept of perceived distraction focuses on the more *negative* aspects of ICT (Campbell & Henning, 2010). Goundar (2014) states that there is limited research about distraction of ICT, but this is an approach that can capture the students' beliefs about ICT as an obstacle for obtaining the learning or performance goals (Ozer & Killic, 2015).

The use of digital technology can be a distraction "that negatively impacts students' classroom performance" (Langford et al., 2016, p. 2).

One example of distraction is that students try to do more things simultaneously (Langford et al., 2016). Multitasking seems to have a negative impact on our concentration because students do not get enough time and quiet to acquaint themselves with the subject matter. The use of ICT could lead to less critical thinking (Greenfield, 2009), lower levels of academic achievements (Junco & Cotten, 2012) and makes learners disconnect from culture and history (Bauerlein, 2008). Research has shown lower levels of GPA among students' using social media (Kirschner & Karpinski, 2010) and among students reporting high frequency of social media use (Junco, 2012). Bowden (2011) finds that technology enhanced classrooms could lead to more isolation, lower loyalty and weaker social connection compared with classrooms without technology.

Langford et al. (2016) discuss if distractions from using ICT arise in educational settings when students are bored or when students have difficulties with following the lectures or tasks. It is therefore possible that distractions from using ICT can be prevented through training, adaptive instruction or by rules about using ICT. However, further research is required on this topic.

There are theories underpinning the importance and benefits of using ICT in education. For example, perceived usefulness of ICT derives from a tradition building on more positive beliefs about ICT. The concepts of perceived distraction and perceived usefulness of ICT are not mutually exclusive, because students can hold both positive and negative beliefs about using ICT at the same time. Adding both concepts in a study broadens the perspective on students' beliefs about ICT.

1.4. Perceived usefulness of ICT

The concept of perceived usefulness of ICT refers to recognizing the value of digital technology for example for solving a problem or doing a task and originated from the theory of planned behaviour and the technology acceptance model (TAM). Davis and colleagues introduced the TAM to "*explain the intentions of using a technological innovation*" (Šumak, Heričko, & Pušnik, 2011, p. 2067). TAM can therefore be used to "*predict the likelihood of a new technology being adopted*" (Turner, Kitchenham, Brereton, Charters, & Budgen, 2010, p. 464). There is an assumption that the acceptance and use of the technology can be explained by beliefs, attitude and intentions, in addition to prior factors (King & He, 2006).

Using technology can be understood as both a dependent and independent variable in the TAM (Alharbi & Drew, 2014). First, prior use of ICT is an independent variable providing information about the extent to which students have gained experience with a system or specific software. Second, the use of ICT is a dependent variable when it comes to estimate how likely it is for an individual to adopt a given technology. For example, Alharbi and Drew (2014) defined experience from using a learning management system as a dependent variable and the intention to use a learning management system an independent variable.

Perceived usefulness of ICT concerns students' beliefs that the use of ICT is beneficial and that ICT can be helpful for achieving goals (Cho, Cheng, & Lai, 2009; Davis, Bagozzi, & Warshaw, 1989). Recent research (Cheung & Vogel, 2013; Liaw & Huang, 2013) indicates the both the prior usage of ICT and the intention to use ICT are correlated with perceived usefulness of ICT. In the present study, we therefore consider perceived usefulness to be variable that is related to students' use of ICT.

As mentioned above, perceived usefulness focuses on the benefits of ICT; corresponding assessments of the construct are therefore formulated positively, such that higher levels of perceived usefulness indicate positive perceptions of ICT. Another key issue related to positive outcomes of ICT is the students' self-efficacy about their own capabilities (Chai, Fan, & Due, 2017; Rohatgi et al., 2016).

1.5. ICT self-efficacy

Self-efficacy derives from the area of motivational research and students' self-beliefs (Bandura, 1997). The objective of studying self-efficacy is primarily to understand peoples' expectations about their ability to achieve a goal, solve a problem, or complete a predefined activity (Yang & Cheng, 2009). Schunk, Meece, and Pintrich (2014) showed that self-efficacy is an important variable to understand peoples' tasks choices, their effort, and achievement. In general, self-efficacy is related with higher levels of achievement (Schunk et al., 2014; Valentine, DuBois, & Cooper, 2004). However, self-efficacy reflects on self-beliefs, and research shows that some students are overconfident about their abilities; others underestimate their abilities, whereas some students have more a more realistic understanding of their own abilities (Moores & Chang, 2009).

Bandura (1997) argues that the strongest predictor of self-efficacy is probably the previous personal experience from a task or an activity. When students participate in an activity, they may find that they can master the task on their own or together with others. These mastery experiences and the ways in which students interpret their capabilities contribute to weakening or strengthening their self-reliance and self-efficacy (Usher & Pajares, 2008). Research has shown prior successful experience with digital technologies can lead to higher levels of ICT self-efficacy (Cassidy & Eachus, 2002). However, this depends on how the students perceive and attribute their use of ICT (Joo, Bong, & Choi, 2000).

Bandura (1997) emphasized the existence of domain-specific self-efficacy beliefs. In other words, individuals' perceptions of their capabilities and expectations about their performance within a specific domain such as ICT may differ from their perceptions in a domain outside of the ICT context. ICT self-efficacy is therefore related to the students' beliefs about their own ICT literacy (Tømte & Hatlevik, 2011; Hatlevik, Ottestad, & Trondsen, 2015).

Recent research shows that students' access to ICT and their experience using ICT are positively related to ICT self-efficacy (Tondeur, Sinnaeve, van Houtte, & van Braak, 2011). Moreover, the intensity of students' leisure use of computers outside of school is positively correlated with their ICT self-efficacy (Meelissen & Drent, 2008). On the other hand, perceived distraction of ICT means having negative experiences with ICT (Palmer et al., 2014). Hence, experiencing the obstacles of ICT use such as distraction could lead to lower levels of ICT self-efficacy.

1.6. Context

Since 2006 the capability to use ICT has been part of the Norwegian curriculum. ICT literacy has been defined as a basic skill in the curriculum meaning, which is considered transversal and fundamental for all subjects (Norwegian Directorate for Education and Training, 2012). Despite this importance, ICT is not a specific subject in the curriculum. However, the use of ICT is operationalized within subjects, and targets grade-specific competence aims. These competence aims are expected to be reached during 2nd, 4th, and 7th grade in primary school and at the end of 10th grade in lower secondary school. After the 7th grade, the students leave primary school and enter lower secondary school – this transition is critical and oftentimes psychologically demanding for Norwegian students, as it provides them with novel learning environments. In the face of required adaptation, students oftentimes compensate these demands by distracting themselves (Hales & Lauzon, 2010), for instance, with digital technologies.

1.7. The present study

One conclusion from the recent research and literature presented above is that more research is required when it comes to scrutinizing and understanding the negative consequences students perceive from using ICT. Research findings underline the importance of varied use of ICT in school and that long hours in front of the computer screen should be avoided (Palm et al., 2007). Coleman et al. (2009) showed that using digital devices could explain variation in perceived discomfort. More specifically, Coleman et al.'s findings suggested that students' identified their exposure to media and digital technology as the main reason for their discomfort, followed by bad posture and engaging in specific activities for an extended time as further reasons. Consequently, we expect ICT use at school and for leisure purposes to be associated with perceived discomfort from using ICT (Hypotheses H1 and H3; see Table 1). Langford et al. (2016) emphasized how using ICT could be correlated with perceived distractions by explaining that technology-rich problems pose high demands on students, such as the demand to perform multiple tasks at the same time. These demands are related to students' working memory capacity and may have detrimental effects on their academic performance in the long run (Bowman, Levine, Waite, & Gendron, 2010; Colom, Martínez-Molina, Shih, & Santacreu, 2010; Johnson, Cohen, Kasen, & Brook, 2007). Goundar (2014) put forth a slightly different line of thinking and argued that students are also distracted by ICT during lectures, especially when they use digital devices for non-academic purposes. These lines of argumentation provide the background for hypotheses H2 and H4.

Albeit the large body of literature on the negative consequences of using ICT excessively, there is also a large body of literature on the positive consequences of using ICT, for instance, to enhance teaching and learning processes inside or outside of schools (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Indeed, embedding ICT as useful tools to solve complex problems or to make use of interactive modes of representation might facilitate the development of conceptual understanding and problem-solving skills (e.g., Cheung & Slavin, 2013; Donnelly, Linn, & Ludvigsen, 2014; Stevenson, Hartmeyer, & Bentsen, 2017; Sung, Chang, & Yang, 2015). Accounting for the fact that ICT use might have positive effects in certain contexts, we extend hypotheses H1-H4 by testing the assumption that an "optimal level" of ICT use for perceived negative consequences exists. In other words, we test the quadratic relations between ICT use for leisure and at school, and perceived distraction and discomfort. Testing whether a curvilinear relation between ICT use and perceived negative consequences of ICT use exists is based on a series of empirical findings: Focusing on adults at work, Ďuranová and Ohly (2016) identified a curvilinear association between ICT-related work demands and employees' well-being. Similarly, Shimazu et al. (2016) found that work-related ICT use and mental health follow an inverse U-shape—again, evidence for a curvilinear relation. Focusing

Table 1
Hypothesized relations between students' use of ICT, perceived negative consequences of ICT use (for health and attention), and beliefs (ICT self-efficacy and perceived usefulness).

Hypothesis 1 (H1)	The use of ICT during lessons is positively related to perceived discomfort from ICT use.
Hypothesis 2 (H2)	The use of ICT during lessons is positively related to perceived distraction by ICT.
Hypothesis 3 (H3)	Leisure use of ICT is positively related to perceived discomfort from ICT use.
Hypothesis 4 (H4)	Leisure use of ICT is positively related to perceived distraction by ICT.
Hypothesis 5 (H5)	The use of ICT during lessons is positively related to ICT self-efficacy.
Hypothesis 6 (H6)	The use of ICT during lessons is positively related to perceived usefulness of ICT.
Hypothesis 7 (H7)	Leisure use of ICT is positively related to ICT self-efficacy.
Hypothesis 8 (H8)	Leisure use of ICT is positively related to perceived usefulness of ICT.
Hypothesis 9 (H9)	Perceived distraction by ICT is negatively related to ICT self-efficacy.
Hypothesis 10 (H10)	Perceived distraction by ICT is negatively related to perceived usefulness.
Hypothesis 11 (H11)	Perceived discomfort by ICT is negatively related to ICT self-efficacy.
Hypothesis 12 (H12)	Perceived discomfort by ICT is negatively related to perceived usefulness.

on 15-years-old students around the globe, the OECD Programme for International Student Achievement (PISA) examined the extent to which ICT use and students' well-being are correlated (OECD, 2017). For most countries, excessive ICT use (i.e., more than 6 h per day) was negatively associated with life satisfaction, perceived loneliness, and bullying. However, these effects varied across different levels of ICT use—a finding that point into the direction of a curvilinear relation between ICT use and the perceived, negative consequences. One may interpret this relation as follows (OECD, 2015, 2017): On the one hand, the use of ICT may enhance life satisfaction, as it provides students with opportunities for entertainment and easily accessible tools for socializing. On the other hand, excessive ICT use comes along with the risk of undermining motivation to learn and concentration, compromising achievement and sense of belonging, and isolating students socially.

Considering the existing research with students and adults, we assume that students' use of ICT at school and for leisure purposes can predict perceived usefulness of ICT and ICT self-efficacy. Following Bandura's argumentation on the explanatory character of positive experiences of ICT use in self-efficacy, we expect ICT use at school and for leisure purposes to be positively related to ICT self-efficacy. This argumentation once again assumes that mastery experiences are an important source of variation and development in self-efficacy (Rohatgi et al., 2016; Usher & Pajares, 2008). Moreover, given the extensive body of literature on technology acceptance, students' prior use of ICT could explain the variance in perceived usefulness of ICT (Lai, Wang, & Lei, 2012; Siddiq, Scherer, & Tondeur, 2016). These expectations provided the background for Hypotheses H5-H8 (see Table 1). For these hypotheses, we will also consider curvilinear or, more specifically, quadratic relations between the use of ICT and self-efficacy, because more frequent use might not directly translate into higher self-efficacy or vice versa—yet, an optimal level of ICT use might exist which is beneficial for students' ICT self-efficacy (Aesaert & van Braak, 2014). PISA 2009 substantiated the proposed, curvilinear relation between ICT use and self-efficacy for most of the participating countries (OECD, 2011). We consequently explore the extent to which quadratic relations between ICT use and self-efficacy exist in addition to the hypothesized linear relations.

Our overarching research goal was to clarify the role of perceived discomfort and distraction for students' self-efficacy and perceived usefulness of ICT in relation to their ICT use. We assume that perceived negative consequences of ICT use predict students' beliefs about their ICT capabilities and the perceived usefulness of ICT. This assumption is based on the finding that negative experiences associated with ICT use – for instance, manifested by physiological issues (Antoine, 2011) – form sources of computer anxiety, which in turn, challenges students' beliefs about the usefulness of ICT and their own abilities in using it (Celik & Yesilyurt, 2013; Simsek, 2011). Saadé and Kira (2007) even showed that the use of ICT – and the experiences associated with it – was related to students' perceptions of the usefulness of ICT via anxiety. This finding provided ground for hypothesizing a link between perceived negative consequences of using ICT and beliefs-related outcomes, namely ICT self-efficacy and perceived usefulness (Hypotheses H9-H12; see Table 1).

Fig. 1 illustrates our hypotheses about the relations among use of ICT, perceived negative consequences of ICT use (i.e., discomfort and distraction), and beliefs-related outcomes. The model postulates that students' use of ICT (leisure use and during lessons) positively relates both to perceived negative consequences of ICT and to beliefs-related outcomes. Further, our

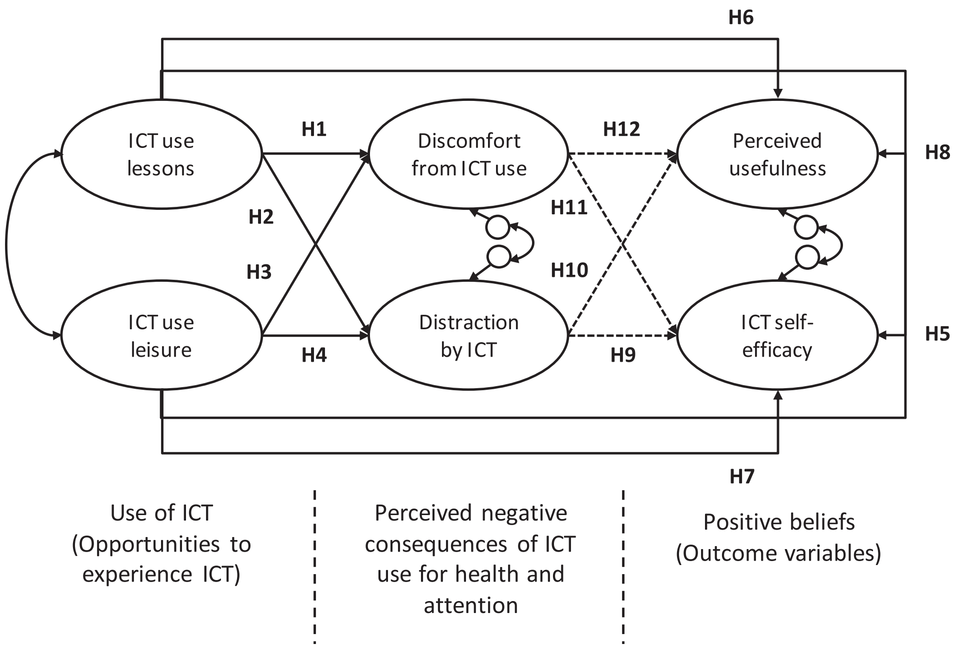

Fig. 1. Hypothesized structural equation model and the corresponding paths. *Note.* The solid lines illustrate a positive relationship and the dotted lines postulate a positive relationship.

assumption is that students who experience discomfort from using ICT and distraction by using ICT are more likely to report lower levels of perceived usefulness of ICT and ICT self-efficacy. The hypotheses are formulated in Table 1.

2. Method

2.1. Sample and procedure

The present study is a cross-sectional study with a stratified sample that has been drawn in two steps. First, based on the geographical location, school size, and school type, 250 schools with students from 7th grade were randomly selected. Second, the principals were asked to randomly choose one class of seventh-graders to participate in the study. Later, the principal or a person appointed by the principal received an email with information about how the students could participate in the study and answer the questions at school. The schools were then asked to set aside time and let the students participate in the study during lesson hours. There have been two main reasons for choosing students in 7th grade: First, in Norway, students leave primary school and enter lower secondary school at the end of 7th grade, such that this grade level represents a key transition point between educational levels. Second, to our best knowledge, only few studies targeted 12-13-year-old students, that is, a group of students' computer science programs are especially targeted at (Kalelioğlu, 2015, pp. 200–210; Sanne et al., 2016).

In total, $N = 1640$ students from 105 schools completed the questionnaire (age: 12–13 years old); the data from two students were excluded from the analysis, because they started the survey but did not complete any question. The response rate was approximately 37% at the school level. The Norwegian Data Protection Authority was notified about the study in advance, and the data collection was carried out adhering to their guidelines.

2.2. Measures

Students worked on an online questionnaire that contained item about use of ICT, discomfort using ICT, perceived usefulness of ICT, distraction by ICT, and ICT self-efficacy. Table 2 consist information about descriptive statistics, medians, skewness, kurtosis, and the standardized factor loadings that were obtained from unidimensional latent variable models for each of the corresponding scales. Twenty-one factor loadings were equal to or higher than 0.50 (see Table 2); the remaining factor loading was still sufficiently high, $\lambda = 0.48$ (Crocker & Algina, 2006). It was therefore possible to establish latent

Table 2
Means, standard deviations, medians, skewness, kurtoses, and factor loadings for all items of the administered scales.

Scale	Items	*M* (*SD*)	*Mdn*	Skewness	Kurtosis	Standardized factor loadings (*SE*)
Use of ICT in lessons (Cronbach's $\alpha = 0.83$)						
	English	2.36 (0.76)	2	0.36	−0.16	0.64 (0.02)**
	Mathematics	2.05 (0.68)	2	0.51	0.22	0.60 (0.01)**
	Norwegian	2.60 (0.73)	3	0.11	−0.37	0.68 (0.02)**
	Science	2.38 (0.76)	2	0.29	−0.22	0.79 (0.01)**
	Social science	2.23 (0.74)	2	0.51	0.22	0.78 (0.01)**
Leisure use of ICT (Cronbach's $\alpha = 0.65$)						
	Chat	3.37 (0.91)	4	−1.01	−0.03	0.50 (0.03)**
	Watch movies	2.81 (0.82)	3	−0.04	−0.80	0.53 (0.03)**
	Play alone	2.71 (1.11)	3	−0.22	−1.13	0.71 (0.02)**
	Play with others	2.48 (1.09)	2	0.01	−1.28	0.86 (0.02)**
Discomfort from using ICT (Cronbach's $\alpha = 0.83$)						
	Sore eyes	1.52 (0.84)	1	1.46	1.53	0.89 (0.01)**
	Headache	1.48 (0.81)	1	1.56	1.42	0.90 (0.01)**
	Pain in arms and shoulders	1.49 (0.83)	1	1.53	1.12	0.79 (0.02)**
Perceived distraction by ICT (Cronbach's $\alpha = 0.77$)						
	Steal time	1.96 (0.97)	2	0.57	−0.84	0.67 (0.02)**
	Disturb	1.82 (0.96)	1	0.83	−0.49	0.86 (0.01)**
	Use time on off-curriculum activities	1.86 (0.94)	2	0.74	−0.56	0.61 (0.03)**
Perceived usefulness of ICT (Cronbach's $\alpha = 0.89$)						
	Help me understand the topic	3.21 (0.83)	3	−0.89	0.22	0.81 (0.01)**
	Makes me want to learn	3.25 (0.87)	3	−1.00	0.21	0.84 (0.01)**
	Is useful to learn subjects	3.26 (0.78)	3	−0.89	0.39	0.86 (0.01)**
	Makes it easier to learn	3.22 (0.82)	3	−0.82	0.05	0.92 (0.01)**
ICT self-efficacy (Cronbach's $\alpha = 0.69$)						
	Download programs	2.66 (0.55)	3	−1.34	0.82	0.76 (0.03)**
	Spreadsheet	2.34 (0.71)	2	−0.60	−0.87	0.59 (0.03)**
	Edit photos	2.60 (0.63)	3	−1.30	0.54	0.66 (0.03)**
	Create a database	1.72 (0.76)	2	0.52	−1.08	0.68 (0.03)**
	Make a presentation	2.57 (0.63)	3	−1.15	0.21	0.48 (0.04)**

Note. Standardized factor loadings are based on the WLSMV estimator. $^{**}p < 0.01$.

Table 3
Correlation matrix for all constructs.

Variables	1.	2.	3.	4.	5.
1. ICT use in lessons	1.00				
2. Leisure use of ICT	0.14**	1.00			
3. Discomfort from using ICT	0.02	−0.12**	1.00		
4. Distraction by using ICT	0.08*	−0.02	0.68**	1.00	
5. Perceived usefulness of ICT	0.08*	0.34**	−0.32**	−0.38**	1.00
6. ICT self-efficacy	0.17**	0.46**	-0.19**	-0.11**	0.30**

Note. Correlations are based on WLSMV estimation. $^{*}p < 0.05$, $^{**}p < 0.01$.

variables as representations of the above-mentioned constructs (see Table 3 for mean, standard deviation, skewness, kurtosis, standardized factor loadings and standard error).

Use of ICT in lessons. The students were asked about the frequency of their ICT use in five mandatory subjects (5 items): English, Mathematics, Norwegian, Science, and Social Science. The corresponding response categories were: *1* = *never, 2* = *monthly, 3* = *at least weekly*, and *4* = *daily*. This scale was adapted from a Norwegian monitoring survey of ICT use in schools (Erstad, Kløvstad, Kristiansen, & Søby, 2005).

Leisure use of ICT. The students were asked about the frequency of their leisure use of ICT for chatting, watching films, individual and collaborative gaming. The corresponding response categories were: *1* = *never, 2* = *monthly, 3* = *at least weekly*, and *4* = *daily*. Adapted from the PISA 2006 study (OECD, 2009; Tømte & Hatlevik, 2011).

Discomfort from using ICT. The students were asked about the frequency of discomfort (sore eyes, pain in neck, and pain in shoulders; 3 items) from using ICT (Palm et al., 2007). The corresponding response categories were: *1* = *never, 2* = *monthly, 3* = *at least weekly*, and *4* = *daily*. The items and the response categories were adapted from Palm et al. (2007).

ICT Self-efficacy. Students were asked to respond to five statements about their own capabilities in using ICT successfully (e.g., to use a spreadsheet to make a graph, to download a program; see Hatlevik et al., 2015). These statements were adapted from the PISA 2006 study (OECD, 2009; Tømte & Hatlevik, 2011). The corresponding response categories were: *1* = *No, 2* = *Yes*, with help from others, and *3* = *Yes*, alone. Unlike alternative ICT self-efficacy measures, three response categories were used in this study to avoid ceiling effects that are often observed in responses on competence-related items (Fraillon, Schulz, Friedman, Ainley, & Gebhardt, 2015).

Perceived usefulness of ICT. Perceived usefulness was assessed by four items about the benefits from using ICT (e.g., it makes me motivated and it helps me learn). The corresponding response categories were: *1* = *disagree, 2* = *partly disagree, 3* = *partly agree*, and *4* = *agree*. This scale was adopted from Sørebø, Halvari, Gulli and Kristiansen (2009).

Perceived distraction of ICT. The students were asked to indicate their agreement to three statements about the obstacles from using ICT (e.g., it makes me loose time and it leads me of-topic). The corresponding response categories were: *1* = *disagree, 2* = *partly disagree, 3* = *partly agree*, and *4* = *agree*. The questions and categories were inspired by Søreby et al. (2009).

2.3. Data analysis

Structural equation modelling (SEM) was used to test the model and the assumed relations between the variables. SEM provides a methodological approach to analyse both the measurement models of the constructs and, at the same time, the structural relations between (latent) variables (Kline, 2016). Moreover, SEM enables researchers to evaluate the fit of a hypothesized model and therefore obtain information about the extent to which the data represent the theory-driven hypotheses (Brown, 2006).

In order to test our hypothesized model (Fig. 1), we used the following fit indices: the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Weighted Root Mean Square Residual (WRMR). Values of the CFI and TLI close to or above 0.95 are considered acceptable, whereas an RMSEA below 0.08 indicates an acceptable fit (Brown, 2006; Hu & Bentler, 1999; Kline, 2016). WRMR values less or equal than 1.0 are suggestive of a good model fit (Yu, 2002). It must however be noted that these cut-off criteria are not to be used as strict guidelines or “golden rules”, as Marsh, Hau, and Wen (2004) suggested. In fact, some of them are sensitive to the number of items that form a scale and the distribution of item responses (Cook, Kallen, & Amtmann, 2009). Given that item responses were based on Likert scales and scales that comprised only three response categories (i.e., that of ICT self-efficacy), we treated these responses categorically and performed mean- and variance-adjusted weighted least squares (WLSMV) estimation (Kline, 2016). This estimation procedure produces reliable parameter estimates for categorical item responses with less than four response categories (e.g., Rhemtulla, Brosseau-Liard, & Savalei, 2012). To check the robustness of the parameter estimates against different treatments of item responses, we also specified the hypothesized structural equation model using robust maximum likelihood (MLR) estimation and continuously treated responses. Overall, the reported model parameters could be replicated – as we will present the model parameters. Missing data for single items ranged between 1.8% and 9.3% and were handled by the pairwise deletion method under the assumption that they occurred randomly (Asparouhov & Muthén, 2010).

To test for potential quadratic relations between ICT use and self-efficacy, and other constructs relevant to our research model, we extended the model by the quadratic latent variables of ICT use in lessons and ICT use for leisure. These quadratic latent variables were created using the orthogonalization approach under the MLR estimation (for details on this procedure, please refer to Marsh, Hau, Wen, Nagengast, & Morin, 2013 and Lin, Wen, Marsh, & Lin, 2010). In this approach, residuals were obtained from regression models that contained the squared responses on ICT use items as independent and the raw item responses as dependent variables (Little, Bovaird, & Widaman, 2006). These residuals are then used as manifest indicators of the quadratic latent ICT use variables.

3. Results

First, structural equation modelling was performed based on WLSMV estimation to examine the model and the expected relations (Fig. 1). As expected, discomfort and distraction from using ICT was negatively related to the two beliefs-related outcomes, ICT self-efficacy and perceived usefulness of ICT. At the same time, discomfort and distraction were positively correlated, indicating that students' perceptions of these two negative consequences from using ICT go together. Along the same lines, ICT self-efficacy and perceived usefulness correlated positively, such that students who perceive their ICT-related competencies as high are likely to perceive ICT as useful, and vice versa. Considerably low correlations occurred between the use of ICT, reported discomfort and distraction; in contrast, the relations among ICT use and the two beliefs-related outcomes were higher. Based on these correlations, the overall model, as shown in Fig. 2, fitted the data well, χ^2 (237) = 725.3, $p < 0.001$; CFI = 0.978, TLI = 0.974, RMSEA = 0.035, 90% CI [0.033, 0.038], WRMR = 1.36. This model explained 24.4% of the variation in ICT self-efficacy and 26.1% of the variation in perceived usefulness. However, the model explained only 1.7% of the variation in discomfort from using ICT and 0.8% of the variation in distraction from using ICT. This finding already indicates that indirect effects of ICT use on ICT-related beliefs via perceived distraction and discomfort, if existent, might be rather weak.

Five out of 15 hypotheses were supported by the analyses (see Fig. 2). Distraction by ICT and ICT use during school lessons were positively related ($\beta = 0.09$, $p < 0.01$), thus supporting hypothesis 2. However, discomfort from using ICT had a negative relation to the leisure use of ICT ($\beta = -0.13$, $p < 0.01$), contrasting hypothesis 3. ICT self-efficacy had a positive relation to the leisure use of ICT ($\beta = 0.43$, $p < 0.01$) and the use of ICT in lessons ($\beta = 0.11$, $p < 0.01$). Furthermore, perceived usefulness had a positive relation to ICT leisure use ($\beta = 0.32$, $p < 0.01$) and the use of ICT in lessons ($\beta = 0.07$, $p < 0.05$). These results provide evidence supporting hypotheses 5, 6, 7, and 8. Finally, perceived usefulness of ICT was negatively related to perceived distraction from using ICT ($\beta = -0.35$, $p < 0.01$), as expected in hypothesis 10.

To test the robustness of our findings, we re-ran the structural equation model again, this time using robust maximum likelihood estimation with continuously treated indicators. Moreover, MLR estimation was applied to further extend the research model by quadratic latent variables. Fig. 3 shows the resultant model parameters.

Overall, the model fitted the data well, χ^2 (235) = 526.2, $p < 0.001$; CFI = 0.967, TLI = 0.962, RMSEA = 0.027, 90% CI [0.024, 0.031], SRMR = 0.031. Deviations of the structural parameters and correlations from those obtained from the WLSMV estimation were only marginal, thus pointing to the robustness of our findings against the two estimation and response treatment approaches.

Finally, the model depicted in Fig. 3 was extended by quadratic terms of the ICT use latent variables, as shown in Fig. 4. The model showed an acceptable overall fit, χ^2 (455) = 971.4, $p < 0.001$; CFI = 0.956, TLI = 0.949, RMSEA = 0.026, 90% CI [0.024, 0.029], SRMR = 0.035. Neither perceived usefulness (ICT use lessons: $\beta = 0.01$, $p = 0.86$; ICT use leisure: $\beta = -0.04$, $p = 0.33$) nor self-efficacy (ICT use lessons: $\beta = -0.01$, $p = 0.86$; ICT use leisure: $\beta = -0.03$, $p = 0.58$) showed significant quadratic relations to the ICT use variables. Along the same lines, neither perceived discomfort (ICT use lessons: $\beta = -0.05$, $p = 0.14$; ICT

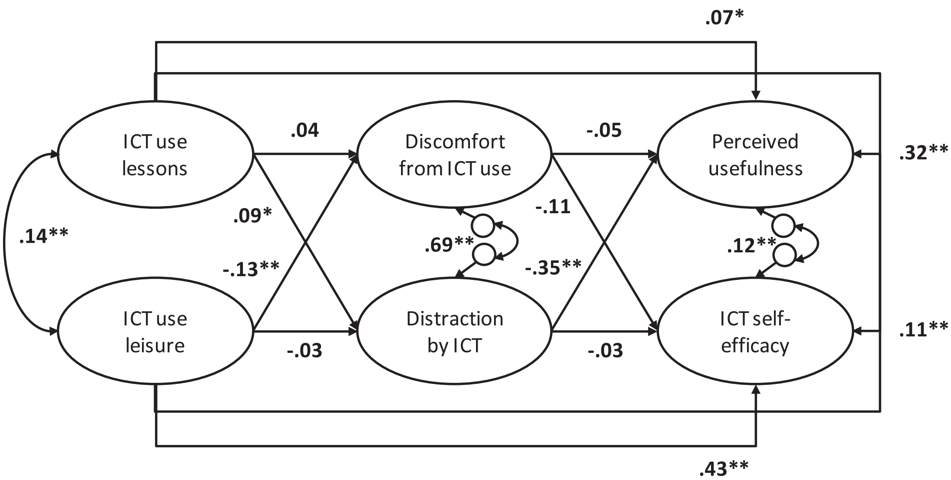

Fig. 2. Results from testing the model about the relationship between use of ICT, discomfort from using ICT, perceived usefulness of ICT, perceived distraction by ICT, and ICT self-efficacy using the WLSMV estimator and categorically treated item responses. *Note. *p < 0.05, **p < 0.01.*

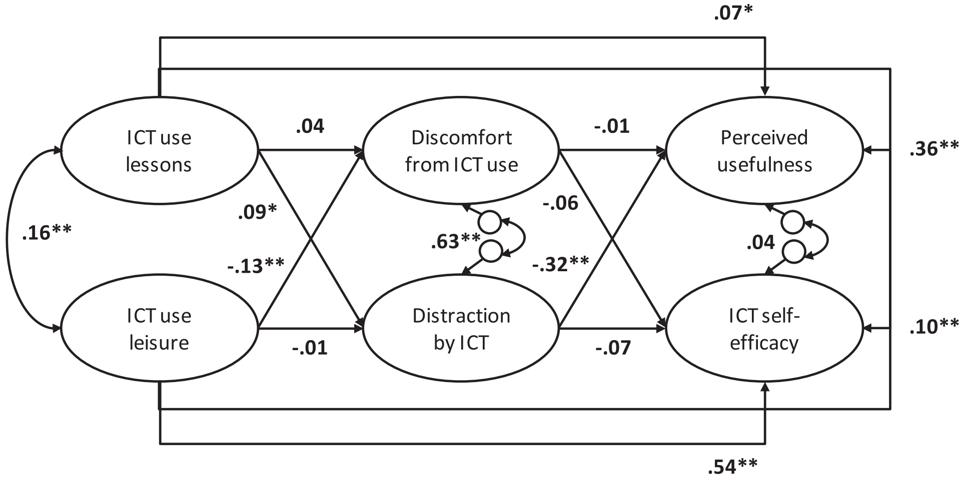

Fig. 3. Results from testing the model about the relationship between use of ICT, discomfort from using ICT, perceived usefulness of ICT, perceived distraction by ICT, and ICT self-efficacy using the MLR estimator and continuously treated item responses. *Note. *p < 0.05, **p < 0.01.*

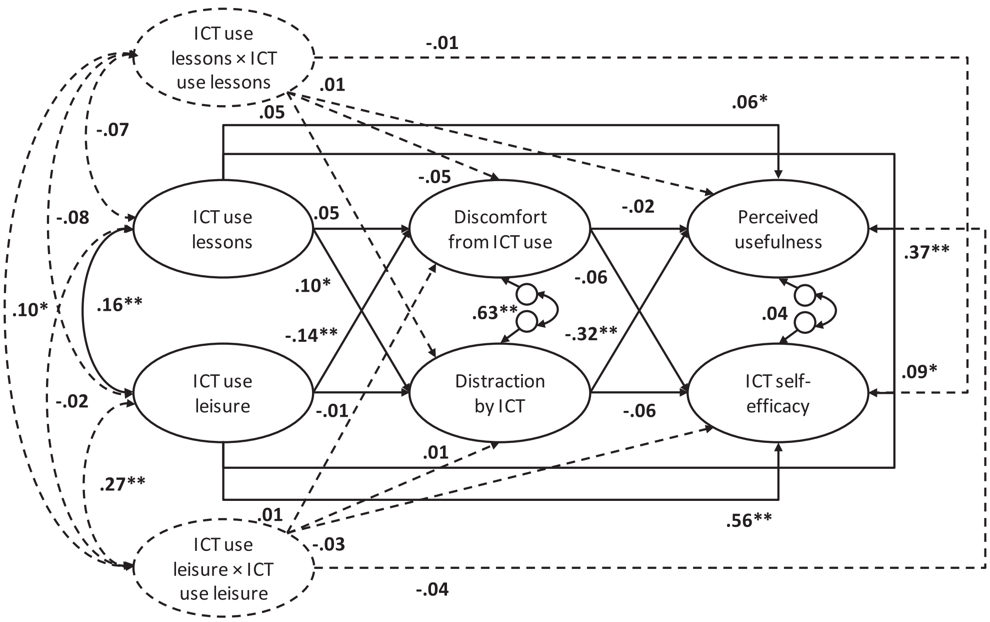

Fig. 4. Results from testing the model about the relationship between use of ICT, discomfort from using ICT, perceived usefulness of ICT, perceived distraction by ICT, and ICT self-efficacy using the MLR estimator and continuously treated item responses and quadratic latent variables of ICT use. *Note*. Dashed lines highlight the relations between the quadratic ICT use variables with all other variables. **p < 0.05, **p < 0.01.*

use leisure: $\beta = 0.05$, $p = 0.22$) nor perceived distraction (ICT use lessons: $\beta = 0.05$, $p = 0.30$; ICT use leisure: $\beta = 0.01$, $p = 0.78$) showed significant quadratic relations to the ICT use variables. Consequently, the expectation to uncover potential curvilinear relations to the use of ICT was not met for the current sample of students.

4. Discussion

This paper addressed the perceived negative consequences of using ICT at school (Dockrell et al., 2010; Langford et al., 2016). These consequences were operationalized by two dimensions, discomfort from using ICT (Palm et al., 2007) and distractions by using ICT (Karsenti & Fievez, 2013). Whereas the former referred to students getting sore eyes, neck pain, or pain in their shoulders when using ICT (Palmer et al., 2014), the latter describes the extent to which students may not be able to focus on a specific task due to distractions from ICT (Goundar, 2014). Based on a hypothesized structural model, we studied the relations among these perceptions, students' ICT use for school-related and leisure purposes, their ICT self-efficacy, and perceived usefulness of ICT. The hypothesized could be confirmed partly.

This study set out with four hypotheses about the relationship between the use of ICT and the perceived negative consequences of ICT (Dockrell et al., 2010; Goundar, 2014). Only one out of the four hypotheses were supported (H2), and it proved to be a weak relationship between ICT use during lessons and distraction by ICT (H2). Our findings contrast the assumption that frequent use of ICT go together with students reporting discomfort and distraction from using ICT (Dockrell et al., 2010; Smith et al., 2008). It may be worthwhile to question why there is not a clear correlation between the use of ICT and the perceived negative consequences of ICT (Langford et al., 2016). One reason could be that in our study a minority proportion of students reported discomfort from ICT use and distraction by ICT. It appears that although students reported a high frequency of ICT use, this may not have any negative consequences with respect to perceived discomfort and distraction, for example, as previous showed by Palmer et al. (2014). An alternative explanation may be that students reported discomfort and distractions for reasons other than barely the use of ICT, for example classroom design (Barrett, Davis, Zhang, & Barrett, 2015), lighting conditions (Winterbottom & Wilkins, 2009), and ergometric properties of school furniture (Brewer, Davis, Dunning, Succop, 2009; Castellucci, Arezes, Molenbroek, de Bruin, & Viviani, 2017). One advice for further studies is to assess students' perceptions of discomfort and distractions related to activities with ICT and without ICT. However, research indicates that students can have suboptimal response strategies when reporting their experience with ICT (Fang, Wen, & Prybutok, 2014; Ravizza, Hamrick, & Fenn, 2014). Students' reports might be prone to social desirability (Dodou & de Winter 2014) and under-reporting actual perceptions of negative consequences associated with the use of ICT (e.g., due to the fear of potential restrictions on the ICT use from teachers or parents). Moreover, notice that the current study targeted students' perceptions of the negative consequences associated with the use of ICT, yet not the actual consequences measured by objective, physiological assessments.

Furthermore, students of this age group might have a considerable high threshold of reporting negative consequences; this threshold might be overshadowed by their motivation to use computers and to achieve using ICT (Hatlevik & Christophersen, 2013; Senkbeil & Ihle, 2017). To further clarify as to whether these reasons apply, we encourage more in-depth investigations of response bias for the administered scales.

Four hypotheses dealt with the relations between use of ICT and positive beliefs as outcomes. Two of these relationships were found to be weak (H5 and H6), but two of the relationships are moderate (H8) and strong (H7). First, leisure ICT use had a strong relationship with ICT self-efficacy. Leisure ICT use can be understood as students' prior ICT use and it can provide information about the experiences students have with ICT. This strong relationship between leisure use of ICT and the ICT self-efficacy is in line with the theoretical assumptions provided by Bandura (1997) who argued that previous personal experience with an activity, for example ICT, can be a very strong predictor of self-efficacy. When students gain leisure experience with ICT this can help them to develop confidence in their capabilities (Rohatgi et al., 2016). Second, leisure ICT use had a moderate relationship with perceived usefulness (H8). One possible explanation for this relationship is that the experiences made through use are a necessary condition for recognizing the value of a given digital technology (Alharbi & Drew, 2014; Scherer, Siddiq, & Teo, 2015). Designated usage pattern is an important prerequisite to make a realistic assessment of what benefit technology can have and the perceived usefulness of ICT (King & He, 2006).

There are also four hypotheses about the relationship between perceived negative consequences of ICT and the positive beliefs. One hypothesis is supported by the study (H10). Perceived distraction by ICT was significantly related to perceived usefulness (H10). Students who experience ICT is a distraction in relation to learning and focus on learning material, are also reporting less benefits from ICT in their own learning. It is important that schools and teachers prevent that the use of ICT contributes to distraction, and instead that schools work to ensure that ICT is used to strengthen the development of use in subjects and to facilitate learning and understanding.

The findings contrast our assumptions that higher levels of discomfort and distraction go together with lower levels of ICT self-efficacy. As mentioned above, experiencing negative consequences from using ICT could be under-reported, or students might have difficulties using ICT for the purposes presented in the items. The latter might lead to lower self-efficacy beliefs (Moos & Azevedo, 2009). An additional explanation could be that experiences of physical pain and psychological imbalance play less role for ICT self-efficacy compared with how students' personal experience of mastery or observing how their peers can master activities within a specific domain, for example ICT. Considering Bandura's (1997) argumentation, these experiences of mastery could develop and sustain subject-domain self-efficacy; in our case, ICT self-efficacy.

It is worth noting that none of our hypotheses on the curvilinear relations among constructs could be confirmed. Albeit the existing body of research on, for instance, the association between ICT use and self-efficacy or ICT use and perceived negative consequences thereof suggests that an "optimal" level of ICT use might exist (OECD, 2011, 2015), there was no evidence in our study substantiating this finding. Generally, the curvilinear effects of ICT use on well-being or health-related variables are weak, and it is therefore challenging to identify these effects in latent interaction models (Marsh et al., 2013). Furthermore, it is currently unclear whether these effects are generalizable across student samples of, for example, different grade levels of age groups. As noted earlier, students in our sample were relatively young such that the curvilinear effects might not yet exist.

Overall, this study has some limitations worth mentioning: First, given the cross-sectional, non-experimental design of the study, the proposed model cannot be interpreted causally; the structural relations among constructs do not represent causal mechanisms. Instead, our study provided a glimpse into potential mechanisms in a relatively young research arena, that is, the relations among health- and beliefs-related constructs in the context of using ICT. These relations are subject to further testing, particularly in longitudinal designs to strengthen the order and causality of effects that might explain variation in discomfort and perceived distraction, as well as ICT self-efficacy and perceived usefulness. Second, it might well be that the relations identified in our study are different for other student samples (e.g., in different grade levels), other nationalities, and alternative measures of the relevant constructs. We therefore encourage research comparing the hypothesized relations across different student samples.

5. Conclusion

Our research presents perspective on the use of ICT that contrasts the potential benefits that might come along with it. In other words, there are a few students who reported that they get sore eyes, pain in neck and shoulders when using ICT. This group is also more likely to report that digital technology distracts them and make them get off-topic during lessons. This perspective on the effects of ICT in terms of distraction complements the concept of perceived usefulness of ICT.

Overall, the findings indicate both positive and negative experiences with ICT. Yet, one may not conclude that the use of ICT has more disadvantages than advantages, particularly when used in schools. The central issue is that school leaders and teachers should think about and plan how ICT can be used in a way to support learning and, at the same time, to prevent that students experience discomfort and distraction, for instance, by tracking the time spent and the activities performed on ICT during lessons. But clearly, there is a need to adjust individual students and this is also in line with descriptions in the national curriculum.

Acknowledgements

We are grateful for the support by The Norwegian Centre for ICT in Education and the Norwegian Directorate of Teaching and Education. The first author's contribution to this study was funded by the FINNUT Young Research Talent Project Grant (NFR-254744 "ADAPT21") by The Research Council of Norway.

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