Students' ICT self-efficacy and computer and information literacy: determinants and relationships

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Abstract

Self-efficacy is an important concept for understanding learning and achievement. The concept covers students' self-confidence and their expectations for future performances. Students' learning experiences are crucial for the development of self-efficacy beliefs, which in the next round may affect students' achievements. The present study explores how self-efficacy can be contextualized with information and communication technology in initially 15 countries. A theoretical model is built and tested in each country based on data from the International Computer and Information Literacy Study 2013. The analyses show that students' self-regulation, experience with technology and socioeconomic background explain the variation in their ICT self-efficacy. Further, gender, self-efficacy and socioeconomic background play an important role for understanding students' computer and information literacy. This indicates that ICT self-efficacy is positively related to computer and information literacy when controlled for other student characteristics and background contextual variables. However, the results also reveal a clear distinction between measures of ICT self-efficacy one hand and computer and information literacy on the other. It is therefore necessary to continue elaborating on the differences between what students belief they can do when using ICT and their actual performance with ICT.

Keywords

ICT Self-efficacy, Computer and Information Literacy, Self-regulated learner, Experience with computers, Socioeconomic background, Gender, Lower secondary school

Introduction

Self-efficacy is an important theoretical framework that can be used to understand students' *confidence* and *beliefs* with respect to their capability to perform specific tasks or activities (Bandura, 1986). To our knowledge, only few studies on self-efficacy have analysed students' confidence in using Information and Communication Technologies (hereafter abbreviated ICT) in relation to their digital literacy. In this regard, the recent International

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Computer and Information Literacy study (hereafter abbreviated ICILS), commissioned by the International Association for the Evaluation of Educational Achievement (hereafter abbreviated IEA) represents a unique source of information to compare students' ICT self-efficacy with their actual Computer and Information Literacy (abbreviated CIL). According to Fraillon et al. (2013:17), CIL refers to "an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in the community".

To date, empirical work related to lower secondary students' self-perception of ICT skills compared with their actual skills is sparse. In our paper this topic will be addressed by exploring ICILS student data from Australia, Chile, Czech Republic, Croatia, Denmark, Germany, Republic of Korea, Lithuania, Norway, Poland, Russian Federation, Slovak Republic, Slovenia, Thailand and Turkey.

Our objective is twofold. First, we examine how personal characteristics and background contextual variables may affect students' ICT self-efficacy and CIL. Second, we investigate how students' ICT self-efficacy and CIL are related after having controlled for relevant personal characteristics and background contextual variables. It is of particular interest to explore student characteristics, home environment and students' use and experience with ICT lying behind the national results. This will be further elaborated in the next two sections.

Theoretical perspectives

This section introduces the two key concepts at the base of this paper: Self-efficacy, and Computer and Information Literacy.

Self-efficacy

The role of self-efficacy has gained considerable attention in research on students' motivation and learning outcomes. Self-efficacy refers to "people's judgements of their capabilities to organize and execute courses of action required attaining designated types of performances" (Bandura, 1986, p. 391). It must be emphasized that actual skills and self-efficacy beliefs are not synonymous in meaning; self-efficacy refers to persons' perceived capabilities and reflects what individuals believe they can do with the skills they possess (Bandura, 1997), whereas actual skills refers to abilities objectively measured. Central in Bandura's notion of self-efficacy is the idea that this personal belief is a major basis of and a direct determinant of individual's behaviour and actions, i.e. students are more likely to pursue activities within their range of perceived competence.

In education, self-efficacy has proved to affect students' choices of activities, effort invested, persistence, interest, achievement (Schunk & Pajares, 2009) as well as the use of self-regulatory processes (Zimmerman, 2000).

Compared to students who doubt their capabilities to perform well, self-efficacious students work harder, persist longer, show greater interest in learning, and achieve at higher levels (Bandura, 1997). They are not afraid to undertake challenging tasks, and are motivated to use cognitive and metacognitive strategies when faced with obstacles or challenges in learning situations (Zimmerman, 2000).

However, it is important to point out the diversity that exists in students' expectations about performance. While some students are rather modest to realistic in their perceived capacities, others are overconfident and thus have unrealistic expectations of what they are able to accomplish. Persons who lack correspondence between their self-efficacy beliefs and performance are described as being poorly calibrated. According to Schunk and Pajares (2009), calibration is important in education. Students who overestimate their competence may sometime fail, which can lower their motivation. On the other hand, students who underestimate what they are capable of doing may be unwilling to try and therefor reduce their acquisition of skills. Research also shows that self-efficacy beliefs can be related to gender and culture (Dettingen, 1995). Despite that girls perform as competently or even better than boys in various academic domains, they are inclined to report lower self-efficacy, especially in mathematics and science (Schunk et al., 2014).

Furthermore, Hargittai & Shafer (2006) reveal how computer-related self-efficacy has been an important extension of the self-efficacy concept. In the domain of information technology, studies point to the crucial role self-efficacy has on individual's behaviour toward using information technologies. Regarding students' expectations of success in performing computer-related tasks, a distinction has been drawn between general computer self-efficacy and task-specific self-efficacy (Marakas et al., 1998). While general computer self-efficacy refers to an individual's judgement of efficacy across multiple computer application domains, task-specific self-efficacy is defined as perceptions of ability to perform specific computer related tasks.

Self-efficacy beliefs are developed through different sources (Bandura, 1997). Students' interpretation of their actual performance is important for their self-efficacy beliefs, and mastery experiences (i.e. performances interpreted as successful) are considered to be the most potent and salient source to gauge students' self-efficacy. In the domain of information technology this implies that perceived mastery experiences in ICT use are important for students' beliefs about their capability to succeed in various digital activities or tasks. Based on a literature review, Moos & Azevedo (2009) emphasize that it is the quality, and not the quantity, of computer experiences that is the most critical determinant in computer self-efficacy. Quality of computer use may be related to technical support and mastery experiences with ICT. Social persuasion (e.g., verbal persuasion or encouragement from teachers, parents, peers) has also turned out to be an effective means to boost self- efficacy. However, it is

important to ensure that the envisioned success expressed through positive feedback or verbal encouragement is attainable.

Computer and information literacy (CIL)

The other central concept in the present study is computer and information literacy (CIL). Several concepts or terms have been used to identify and describe what students should be able to achieve with digital tools and technology (Ala-Mutka, 2011), e.g., digital competence (Calvani et al., 2012), ICT literacy (Erstad, 2006); digital literacy (Mioduser et al., 2008), CIL (Fraillon et al., 2013), 21st century skills (Binkley et al., 2011), and digital skills (Zhong, 2011). One common feature of these concepts is that a term concerning digital technology (e.g. ICT, Internet or computer and information) is combined with having the capability to use or benefit from using this (e.g. skill, competence or literacy) (Ferrari, 2012). Another common feature is that these concepts describe achievements with ICT as an independent learning area in addition to the traditional disciplines. This is knowledge that students' readily can "adapt and transfer to new contexts" (Fraillon et al., 2013, p. 10).

The ICILS study applies the concepts of ICT literacy when describing CIL of students'. The concept is defined as the ability "*to use computers to investigate, create, and communicate in order to participate effectively*" in various areas of life (Fraillon et al., 2013, p. 17). Furthermore, Fraillon et al. (2013; 2014) only define the personal computer as part of CIL, whereas the ICT literacy concept includes a broader context and diversity of tools and digital media.

Within the ICILS framework (Fraillon et al., 2013), CIL consists of two overarching conceptual categories (i.e., strands), which are divided into seven aspects or content categories within each strand. The first strand, *collecting and managing information,* includes the more practical understanding of how to use a computer, and the capability to acquire, evaluate and manage information. This is in line with other descriptions and definitions of ICT literacy (e.g., Binkley et al., 2012). The second strand, *producing and exchanging information,* includes safe and secure use of information together with communication and the transformation and creation of information. Ferrari (2013) also mentions similar aspects in her study. However, the distinction of the two strands in the ICILS framework with the underlying aspects is not supported by empirical factor analyses. One reason may be that the concepts are overlapping. For example, the process of creating something (Strand two) often involves accessing and evaluating information (Strand one). In addition, when accessing information (Strand one), it often requires to be aware of using information safely and securely (Strand two). Thus, one can assume that these strands are more theoretical in their distinction, and therefore they are difficult to separate in authentic use of computers.

Prior research

According to a social cognitive perspective, both personal and environmental factors have impact on the development of students' self-efficacy beliefs and computer and information literacy. In this section an overview of relevant research on ICT self-efficacy and CIL is given. Personal characteristics deal with students' ICT experience, their ICT use (at home and school), self-regulation, and gender. The environment is represented by students' home background.

ICT self-efficacy and CIL

Studies of self-efficacy emphasize that high domain specific self-efficacy can be important for developing digital competence (Krumsvik, 2011; Tømte, 2011) and for using technology in learning (Solhaug, 2009; Devolder et al., 2012). Some studies have found positive correlation between students' capability to accomplish ICT related tasks and their ICT self-efficacy (Wan et al., 2008; Yang and Cheng, 2009). Also in the ICILS 2013 study positive and statistically significant correlations were found between basic ICT self-efficacy and students' CIL at both the international and national level (Fraillon et al., 2014). However, in the ICILS study personal characteristics and background context variables were not taken into account when analysing students' self-efficacy beliefs.

Students' use of computers at school

Some studies have examined the impact of ICT use at school on students' learning outcomes, and more recently on students' digital competence. For example, secondary analyses of PISA data consistently show that students' test score does not increase as students' use of computers for school-curricula-related activities increases (e.g., Biagi and Loi, 2013; Spiezia, 2010; OECD, 2010). Further, analysis based on the results from the digital reading test in PISA 2009 shows that ICT use in schools is negatively correlated with digital reading scores (Frønes and Narvhus, 2011; OECD, 2011). Finally, recent studies either report no significant relationship between digital competence and computer use in school (Claro et al., 2012) or a negative correlation (Hatlevik et al., 2015). Thus, according to prior research the relationship between students' use of technology in school and their digital skills is somewhat inconsistent.

Experience with computers and use of technology outside school

Research has shown that students' experience with computers as well as their access to technology is positively related to their ICT self efficacy (Tondeour et al., 2011) and ICT literacy (Fraillon et al., 2014). In addition,

Meelissen and Drent (2008) found that the intensity of computer use outside school and students' self-efficacy in computer use had a positive effect on their computer attitudes (i.e. enjoyment, utility perceptions). Studies also show that students use ICT much more frequently at home than in school (e.g., Eurydice, 2011; Wastiau, Blamire, Kearney and Quittre, 2014).

ICT self-efficacy has also been studied in relation to people's abilities to navigate and communicate on the Internet. Individuals' use of Internet play an important role in their social and professional lives, and Internet self-efficacy focuses on what a person believes he or she can accomplish online. According to Eastin and LaRose (2000), people having little confidence in their ability to use the Internet, who are dissatisfied with their Internet skills or are uncomfortable using the Internet are said to have weak self-efficacy beliefs. Their analyses revealed that Internet usage, prior Internet experience, and outcome expectations were significantly and positively correlated to Internet self-efficacy. However, prior Internet experience turned out to be the strongest predictor of Internet self-efficacy.

Self-regulated learning

Students who are able to take responsibility of their own learning can be characterized as self-regulated learners (Schunk et al., 2014). A literature review concludes that computer self-efficacy plays a crucial role for students' learning in computer-based learning environments (Moos and Azevedo, 2009). Results show that computer self-efficacy is related both to students' learning processes and learning outcomes. Self-regulated learning (SRL) has therefore become an important research area in the field of educational research. SRL refers to the process where learners take the initiative to adjust their cognition, motivation, and behaviour in order to accomplish tasks or achieve learning goals (Zimmerman, 2000). Self-regulated learners possess a variety of strategies and are able to adapt them to different learning situations.

Gender

Students' computer self-efficacy has also been studied from a gender perspective, and the research findings are quite consistent. Girls seem to be less confident than boys. Recent research indicates that males seem to overestimate their ICT literacy, whereas females seem to underestimate it (Hargittai and Shafer, 2006; Litt, 2013; Meelissen and Drent, 2008; Tsai et al., 2010; Tømte and Hatlevik 2011; Vekiri and Chronaki, 2008). Especially in more complex computer tasks, male students tend to have more confidence in their computer abilities than their female peers (Meelissen and Drent, 2008; Vekiri and Chronaki, 2008). These gender differences were registered as early as fifth and sixth grade. In the ICILS 2013 study, larger gender differences in ICT self-efficacy were

observed when conducting advanced ICT tasks compared to basic tasks. This tendency was registered across countries (Fraillon et al., 2014).

Nevertheless, when it comes to students' actual achievement (i.e., ICT literacy measured by a test), the findings are less consistent. Some studies report no gender differences (Hargittai and Shafer, 2006; Hatlevik and Christophersen, 2013; Van Deursen and Van Dijk, 2009), while others find that males perform better than females (Calvani et al., 2012; Gui and Argentin, 2011; Van Deursen, 2012). Finally, in a range of studies females demonstrate significantly higher levels of ICT literacy than males (Ainley et al., 2007; Baek, Kim and Kim, 2009; Fraillon et al., 2014).

Home background

A large number of young people are exposed to computers at home from an early age. Within the framework of social cognitive theory (Bandura, 1997), it is assumed that students' interactions with others (e.g., family members) are central in their out of school experiences with technology. Children's perceptions of support from parents and others may therefore be crucial for their ICT self-efficacy. When parents involve in their children's school-related activities, provide encouragement and express positive expectations, children are more likely to have good self-efficacy beliefs for school learning (Schunk and Pajares, 2009). However, low social economic status (SES) parents do not always have the educational experiences and resources to foster their children's learning. According to Becker (2000), disadvantaged students are less likely to have digital literate parents. A growing number of empirical studies unambiguously conclude that students' family background and CIL are related (Claro et al., 2012; Fraillon et al., 2014; Goldhammer et al., 2012; Hatlevik et al., 2015). In this regard, home background is often resembled as students' cultural capital (e.g., Claro et al., 2012; Hatlevik et al., 2015), migration status (e.g., Kuhlmeier and Hemkler, 2007), language integration (e.g., Hatlevik and Christophersen, 2013), parental educational attainment and occupational status (e.g., Fraillon et al., 2014), and by composite indicators capturing students' family socio-economic status (Fraillon et al., 2014).

Research findings also indicate that girls at elementary school level perceive less support than boys when it comes to experiencing support for learning how to use computers (Meelissen and Drent, 2008; Vekiri, 2010; Vekiri and Chronaki, 2008). Parental support was the factor that most strongly was associated with boys' and girls' computer self-efficacy (Vekiri and Chronaki, 2008), and gender differences in computer attitudes seem to be related to gender differences in students' perceived encouragement from their parents (Meelissen and Drent, 2008).

The present study

In the research literature about technology there is a lack of empirical work relating self-perception of skills to actual skills. Based on theory and previous research, we argue that both personal factors and home environment can predict students' ICT self-efficacy and achievement with ICT. In the present study, the influence of personal characteristics and home background on ICT self-efficacy and CIL is explored. This leads to the following research question:

1) *How do students' personal characteristics and background contextual variables affect their ICT self-efficacy and CIL?*

In the present study students' personal factors are represented by their ICT experience (number of years) and ICT use (at home and in school), in addition to self-regulation and gender. Students' home environment is represented by the family socio-economic status.

Based on previous research, it is reason to expect that students' socio-economic status predicts ICT literacy (Goldhammer et al., 2012) and self-efficacy beliefs (Vekiri, 2010). Further, we assume that being a boy is positively related to ICT self-efficacy (cf. Litt, 2013; Meelissen and Drent, 2008; Tsai et al., 2010; Tømte and Hatlevik 2011; Vekiri and Chronaki, 2008) and negatively related to CIL (Ainley et al., 2007; Baek, Kim and Kim, 2009). An important prerequisite for being self-regulated is to hold positive self-efficacy beliefs about one's capabilities to succeed on specific learning tasks (Zimmerman, 2000). To date, studies focusing on the impact of SRL in ICT learning are lacking. However, according to Moos and Azevedo (2009) computer self-efficacy is related to students' learning processes and learning outcome.

Several surveys have documented that students primarily use computers at home. For example, an analysis of the European Survey of Schools data shows that "ICT-based activities related to learning at home are more frequent than ICT activities at school" (Wastiau et al. 2014, p. 17). Research findings show that ICT use at home is related to higher levels of ICT self-efficacy (Tondeour et al., 2011) and CIL (Hatlevik et al., 2015). In addition, students' experience with technology is associated with higher levels of ICT self-efficacy (Meelissen and Drent, 2008; Tondeour et al., 2011). However, when it comes to the relationship between ICT use at school and CIL, recent research findings report a lack of positive relationship (Biagi and Loi, 2013; Claro et al., 2012; Hatlevik et al., 2015).

As previously highlighted, it is important to make a distinction between ICT self-efficacy and actual digital skills, although research findings in various subject areas have revealed a close relationship between these two phenomenons. Also in the domain of digital technology, recent research has indicated that higher levels of ICT self-efficacy can predict higher levels of CIL (Krumsvik, 2011; Tømte, 2011). However, research has also revealed that there may be lack of correspondence between self-efficacy beliefs and performance. For example, some students can be overconfident and thus have unrealistic expectations of what they are able to accomplish on their own, while others may underestimate their digital skills (Meelissen, 2008). The ICILS study gives a unique opportunity to scrutinize the

relationship between ICT self-efficacy and actual performance (CIL). This leads to the second research question:

2) *How is the relationship between students' ICT self-efficacy and CIL after having controlled for relevant personal characteristics of the students and background contextual variables?*

In the international ICILS report (Fraillon et al., 2014) personal characteristics and background context variables were not taken into account in the analyses of the relationship between students' self-efficacy beliefs and CIL. By controlling for these variables, our analyses will represent an extension of previous research, i.e. as we estimate the "net correlation" between self-efficacy and CIL.

Figure 1 is based on the assumptions above. Figure 1 depicts the path model estimated in each of the countries considered in this study. The independent variables are on the left side of the model, while the two dependent variables (self-efficacy and CIL) are on the right side inside the grey area. Finally, the arrows represent the relationships that were tested and their direction.

Insert figure 1

Methodological approach

The ICILS study was conducted in 2013 with almost 60.000 students from more than 3.300 schools in 21 countries or school systems. The ICILS investigates the extent to which eight grade students around the world have developed *CIL* to support their capacity to participate in the digital age[2]. ICILS assessed students' CIL by means of a purpose-designed computer-based test environment. In addition, it gathered representative student information through a questionnaire administered to the students immediately after they had completed the CIL test. This makes it possible to link students' test performances to information about the context in which these competencies have been developed. This study uses students form Australia, Chile, Croatia, Czech Republic, Denmark[3], Germany, Republic of Korea, Lithuania, Norway, Poland, Russian Federation, Slovak Republic, Slovenia, Thailand and Turkey. The sample used for the estimates is composed of 45,910 students in 2,592 schools (table 1), and the actual numbers of students in the analyses are presented in table 4.

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[2] In Norway 9th graders were chosen to participate in the survey because they have, on average, the same age as 8th graders in the other countries.

[3] Denmark did not meet the sampling requirements for the study, but analyses support that data was representative for the population group (Puck and Bundsgaard, 2014).

Sample

The IEA Data Processing and Research Center (DPC) in Hamburg used a stratified two-stage probability cluster sampling design in order to conduct the school sample selection for all ICILS countries / education systems. During the first stage of the sampling, schools were selected systematically with probabilities proportional to their size as measured by the total number of enrolled target-grade students. During the second stage, the DPC used a systematic simple random sample approach to select students enrolled in the target-grade within the participating schools (Meinck, 2015, p. 73). Given that students within the same school are likely to be more similar to each other than compared to individuals in other schools, the sampling design of ICILS violates the assumptions of independence of observations, which is at the base of any ordinary least square regression model (e.g., Luke, 2004). Ignoring the nested nature of the data can lead to biased results. In particular the standard error of the regression coefficients may be underestimated because dependences in the data lead to an overestimation of the effective sample-size (e.g., Cohen, 1988). Underestimating the standard error results in incorrect estimates of the confidence intervals of the regression parameters and in biased statistical inferences (e.g., Lee and Forthofer, 2006). To account for the nested nature of the data, our analyses consider school-clustered standard errors (Cameron and Trievedi, 2005).

Insert table 1

Instruments

Dependent variables

Computer and information literacy.

ICILS assesses students' computer and information literacy by means of a purpose-designed computer-based test environment. The questions and tasks constituting the test environment were organized in four test modules, each of which took maximum 30 minutes to complete. The students completed two modules randomly allocated from the set of four. Rasch IRT techiques was used to derive students' CIL test scores from the data collected through the test environment. The CIL test scale developed by the IEA has a mean of 500 points (i.e. the *ICILS average score*) and a standard deviation of 100 points for the equally weighted national samples (Fraillon et al., 2014, p. 72).

ICT self-efficacy

ICILS operationalizes the concept of self-efficacy using two different scales: the first measures *students' confidence in solving basic computer-related tasks* and the second measures *students' confidence in solving advanced computer-related tasks*. However, this paper focuses exclusively on students' confidence in solving basic computer-related tasks.

The basic ICT self-efficacy scale covers the following six specific computer-related tasks: *Search for and find a file on a computer; Edit digital photos or other graphic images; Create or edit documents; Search and find information on the Internet; Create a multi-media presentation* and *Upload text, images or video to an online profile*. The response categories are "I know how to do this," "I could work out how to do this," and "I do not think I could do this". This construct has an average reliability of 0.76 across national samples with Cronbach's alpha coefficients ranging from 0.64 to 0.86. The scale measuring students' self-efficacy in basic ICT skills has an ICILS 2013 average score of 50 points and a standard deviation of 10 points (Fraillon et al., 2014, p. 158). The average values (and the corresponding standard errors) of the dependent variables are reported in Table 2.

Insert table 2.

Independent variables

Family background and personal characteristics

      Socioeconomic background. The ICILS database includes a composite index reflecting students' socioeconomic background. The values of this index, the *national index of students' socioeconomic background*, have been standardized in order to have national averages of 0 and national standard deviations of 1. For a given country, a one-point difference on the scale of the index represents a difference of one standard deviation on the distribution of this measure (for more details on this see Fraillon et al., 2015: 187).

      Gender. The relationship between students' gender and the dependent variables was estimated using a dummy variable equal to 1 for female students and to 0 for male students.

      Self-regulation. The students were also asked to indicate who mainly had taught them the following ICT activities: communicating over the internet, creating documents for school work, changing computer settings, finding information on the internet, and working in a computer network. They had to choose one of the following response alternatives: i) I mainly taught myself; ii) my teachers; iii) my family; iv) my friends; v) I have never learned this. Based on the answers to this question, we created a dummy variable equal to 1 for the "self-regulated" learners" and 0 otherwise. A student is considered as "self-regulated" if (s)he declared to have learned by him/her

self a number of tasks that is strictly higher to the overall number of taks that (s)he learned with the help of teachers, family and friends.

Experience with computers. Consistently with the IEA report *Preparing for Life in a Digital Age*, this paper models students' experience with computers as a categorical variable reflecting how many years a student have been using computers. This variable can take values 0, 2, 4, and 6 years.

Use of ICT at school. In this paper we explore the relationship between the dependent variables and frequent computer use at school using a dummy variable equal to 1 for the students reporting to use computers at school (at least once a week).

Use of ICT at home. Most students have access to computers at home. We explore the relationship between the dependent variables and frequent computer use at home using a dummy variable equal to 1 for the students reporting to use computers at home (at least once a week).

The average values (and the corresponding standard errors) of the independent variables are presented in Table 3.

Insert table 3.

Analyses

The research questions addressed in this paper are answered by means of path analyses performed one country at a time using students' total weights and CIL plausible values (five). In addition, the nested structure of the data is taken into account estimating school-clustered standard errors. Path analysis can be seen as a multivariate regression model – i.e., a regression analysis that simultaneously considers multiple dependent and multiple independent variables, in contrast to conventional regression analyses that are restricted to a single dependent variable (Geiser, 2013, p. 62). In our case we take into consideration two dependent variables, ICT self-efficacy and CIL.

Different indices are used to evaluate the fit of estimated model to the data (Brown, 2006). First, a chi-square test is used to examine whether there is a difference between the model and the empirical data. The model is accepted with a non-significant chi-square test. However, according to Guay et al. (2014) a chi-square test is sample sensitive, and therefore the ratio of chi-square to its degree of freedom, i.e. χ^2/d.f. < 3, is also used to evaluate the fit. Second, the following two comparative fit indices were used: The *Comparative Fit Index* (CFI), and the *Tucker-Lewis Index* (TLI), together with the *Root Mean Square error of Approximation* (RMSEA), and the *Standard Root Mean Square Residual* (SRMR). A model with acceptable fit should have CFI and the TLI

above 0.95, RMSEA and SRMR below 0.8 and 0.6, respectively (e.g., Geiser, 2013; Hu and Bentler, 1999; Kline, 2005).

Results

Table 2 provides information about the CIL test score and the ICT self-efficacy. The interclass correlation (ICC) shows low levels of variation in ICT self-efficacy between schools in most countries. When it comes to CIL, the results show that in some countries (Germany) more than 50% of the variation in CIL is between schools, whereas in other countries (Slovenia and Norway) the variation between schools are below 15%. Further, table 3 provides information about the independent variables in the model.

Table 4 shows the results of the number of students in the analyses and the fit statistics[4]. Due to missing data, there are a lower number of students (from all countries) in the analyses compared with number of students in the sample (table 1).

The chi-square is non-significant for four countries (Croatia, Czech Republic, Germany and Norway), which means that the model holds for these countries. Further, given that the chi-square test is sample sensitive, the ratio of chi-square to the degrees of freedom is acceptable for ten other countries[5]. The level of chi-square is too high in Thailand, and the country is therefore not included in the final analyses. The remaining 14 countries have acceptable levels of CFI, TLI, RMSEA and SRMR (see table 4).

Insert table 4.

The first research question is about how students' personal characteristics and background contextual variables affect ICT self-efficacy and CIL. In figure 1, five variables are related to ICT self-efficacy. Analyses (see table 5) show that in all 14 countries self-regulation is significantly and positively related to ICT self-efficacy. The loading varies across the countries, from $r = 0.15$ (Croatia, Russian Federation and Turkey) to $r = 0.27$ (Slovenia). In nine countries ICT self-efficacy is significantly higher for female than for male students. The loading varies from $r = 0.04$ (Poland) to $r = 0.15$ (Chile). Furthermore, in 11 countries students' ICT self-efficacy beliefs increase significantly with family's socio-economic background. The loading varies from $r = 0.07$ (Germany) to r

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[4] Mplus version 7

[5] Australia, Chile, Denmark, Korea, Lithuania, Poland, Russian Federation, Slovak republic, Slovenia and Turkey

= 0.15 (Korea). Finally, students' experience with computers (i.e. number of years) and their use of computers at home at least once a week are significantly and positively related to ICT self-efficacy in all countries (except of ICT use at home in Denmark). Students' experience with computers is positive and significant in all countries and varies from r = 0.07 (Germany and Russian Federation) to r = 0.20 (Turkey).

Table 5 also reports on the amount of variance in ICT self-efficacy explained by the model. Depending on the country considered, the proposed path model explains between 5% (Germany) and 15% (Turkey) of the variance in students' ICT self-efficacy. In eight countries the path model explain 10% or more of the variation.

In figure 1, five variables are related to CIL. Analyses of the data (see table 6) show that in all 14 countries being female and family's socio-economic background are significant predictors of CIL. The factor loading for gender varies across the countries, from r = 0.04 (Turkey) to r = 0.23 (Slovenia). The factor loading also varies across the countries for family's socio-economic background, from r = 0.13 (Korea) to r = 0.36 (Chile and Germany). In many countries, students' experience with computers and use of computers at home are significantly correlated with CIL. The number of years with ICT experience is positive on CIL in 12 countries, and it varies from r = 0.05 (Germany) to r = 0.32 (Turkey).

The second research question is about the relationship between students' ICT self-efficacy and CIL. When controlling for students' personal characteristics, background contextual variables and use of computers at home at least once a week, the results (table 6) show that ICT self-efficacy is a significant predictor of CIL in all countries. The strength of the relationships between these two dimensions varies between r = 0.17 (Denmark) and r = 0,30 (Slovakia).

As shown in table 6, the presented model explains 20% or more of the variance in students' CIL in most of the countries. Denmark and the Czech Republic are the only two exceptions (with a portion of 16% and 19%, respectively, of variance explained).

Insert table 5.

Insert table 6.

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Discussion

The present study addresses two research questions. We examined both research questions by testing a model based on a theoretical relationship between contextual variables, students' personal characteristics, students' use of ICT, ICT self-efficacy, and computer and information literacy. Path analyses show that the model has acceptable fit measures for the following 14 countries: Australia, Chile, Czech Republic, Croatia, Denmark, Germany, Republic of Korea, Lithuania, Norway, Poland, Russian Federation, Slovak Republic, Slovenia and Turkey. The discussion of the research questions is therefore based on results from these countries.

The first question focuses on identifying how students' personal characteristics and contextual variables affect their ICT self-efficacy and CIL. The results show that being a self-regulated learner and an experienced ICT user are the most important variables when it comes to explaining variation in students' ICT self-efficacy. Based on Zimmerman (2000), a possible explanation for the role of self-regulation is that self-regulated learners typically enter learning situations with a strong sense of self-efficacy. They view learning as something they do for themselves rather than something that is done to or for them. As self-regulated students work on a task, they evaluate their progress, and positive self-evaluations enhance self-efficacy and maintain motivation (Schunk et al., 2014; Zimmerman, 2000). Students who feel efficacious are also apt to use effective strategies, i.e. they use proper procedures, monitor their progress, and adjust strategies if needed. Their choice of procedures and strategies are also based on prior experience in similar learning situations.

Further, the result shows that students' ICT experience measured by number of years also predicts students' ICT self-efficacy. However, in the present study a rather rough indicator was used to indicate students' experience with computers (0, 2, 4, and 6 years). In addition, this kind of measure does not provide information about the skills or quality invested in students' ICT use. In our opinion more research is required in order to identify qualities of ICT experience and to examine if there are specific characteristics of the experience leading to increased levels of ICT self-efficacy.

According to our analysis, students' socioeconomic background has a weak, positive relationship with students' ICT self-efficacy in some countries (i.e., Australia, Korea and Poland), while the relationship was not significant in other countries (i.e., Czech Republic, Denmark and Slovenia). However, in all countries students' socioeconomic background has a moderate, positive relationship to students' CIL. Thus, *socioeconomic status* seems to be the most important predictor of students' computer and information literacy across all countries. This indicates that students' socioeconomic background could be one of the drivers of the so-called second level of digital divide. *Equity* in general, and *digital equity* in particular, is important in several educational systems (e.g.,

Chile, Denmark and Norway). Therefore, it is required that schools take action in order to obtain digital equality and to reduce the digital divide.

We assumed that boys would report higher levels of ICT self-efficacy compared with girls. However, this was not supported by our analyses. Significant gender differences in ICT self-efficacy were not registered in Denmark, Germany, Norway and Turkey. Females reported significantly higher levels of ICT self-efficacy in the other 10 countries (Australia, Chile, Czech Republic, Croatia, Republic of Korea, Lithuania, Poland, Russian Federation, Slovakia and Slovenia). This finding may indicate that the traditional perceptions about boys being more confident than girls (Hargittai and Shafer, 2006; Tømte and Hatlevik, 2011) are about to diminish.

When it comes to students' performance on the CIL test, females are outperforming males in all countries. This is noteworthy as some countries, for example the Nordic countries, are concerned with gender neutrality in school and therefore similar performance of females and males could be expected. As mentioned earlier, higher levels of gender differences were registered in CIL compared with students' ICT self-efficacy.

The relationship between students' use of computers at school and their computer and information literacy is unclear. It seems as a paradox that students' use of computers at school does not lead to higher levels of CIL. One possible explanation could be that the frequency of use does not capture the assumed qualities of using and learning from ICT.

The second research question in the present study deals with how students' ICT self-efficacy and CIL are related after having controlled for relevant personal characteristics of the students and contextual variables. Analyses revealed that students' level of ICT self-efficacy explained their level of CIL in all 14 countries. However, when considering the strength of the relationship, the results show that the regression coefficients between ICT self-efficacy and CIL varied from r=0.17 in Denmark to 0.36 in Korea. This indicates a small to moderate positive relationship (Cohen, 1988). This result indicates that it is necessary to distinguish between what students think they are capable of mastering with ICT and their actual performance. The validity of self-reported skills measures have been questioned because of the discrepancy found between users' self-reported or perceived skills and their performance-based skills (Litt, 2013). Some students underestimate their capabilities whereas others overestimate their ICT skills, whereas the CIL test measures their achievement and performance based on a set of tasks. It is also interesting that the ICT self-efficacy measure does not seem to be dependent on the schools (as the variation between schools are low for most countries.

Overall, when taking a closer look at students' ICT self-efficacy and CIL in the path model, the model is more successful in explaining variation in CIL (from 16% to 32%) compared to explaining variation in ICT self-

efficacy (from 5% to 15%). One reason could be that the main objective of the study is to examine students' computer and information literacy, and that the study was designed to identify the drivers of CIL more than the drivers of ICT self-efficacy. Overall, it seems important to investigate how to operationalize ICT self-efficacy, and to identify other possible variables that to a larger degree can explain students' ICT self-efficacy.

Concluding remarks: Implications and further research

The model was partly supported in 14 countries, but not all the paths were supported in all these 14 countries. It could be interesting to have a closer look at the five countries were all the paths were found significant. Are there any similarities between these countries when it comes to the implementation and use of ICT at schools? However, this requires insight into the national systems in these countries.

The ICILS 2013 study has a cross-sectional design, and the analyses of the path model have to be interpreted from this point of departure. A longitudinal design could be beneficial, for example to control for country-fixed effects and for selection biases.

Hopefully, this study could motive for further research on similarities and differences across countries when it comes to the relationship between personal characteristics, background contextual variables, ICT self-efficacy and CIL. However, the recent analyses show that the model has equal form for five countries, and analyses of loadings and thresholds across groups are therefore not relevant (Brown, 2006).

Students' socioeconomic background is important for understanding variation in students CIL, and in some countries students' ICT self-efficacy. This means that family background may explain digital inequity and digital divide. In order to prevent and dismiss digital divide schools have to take actions in order to help students develop ICT literacy.

Girls obtain higher CIL scores than boys, and in many countries they report higher ICT self-efficacy. This result may indicate that a change has occurred. The present study does not provide any information about why these changes have occurred. In addition, it could be interesting to scrutinize the gender differences found in computer and information literacy, in order to gain more knowledge about what implications this may have for instruction in schools.

A positive relationship between ICT self-efficacy and CIL was found, but this relationship varies from low in some countries to moderate in other countries. We do not know if increased ICT self-efficacy would increase CIL, and it is still uncertain if more emphasise on the development of students ICT and self-efficacy in schools

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will strengthen increase their computer and information literacy. It seems necessary with longitudinal studies scrutinizing the relationship between ICT self-efficacy and CIL.

Finally, further research, both empirical and theoretical, is needed to identify other factors related to ICT self-efficacy and CIL.

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