Chapter 6
Digital Inclusion in Norwegian and Danish Schools—Analysing Variation in Teachers' Collaboration, Attitudes, ICT Use and Students' ICT Literacy

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Abstract The capability to use digital technologies in an appropriate way has become a fundamental requirement of everyday life and wide adoption of digital technologies has gained a firm footing into the educational systems. Equity is a central goal in the Nordic model and ICT integration policies are warranted at the national level along with massive improvements in ICT infrastructures. The schools in their efforts towards realizing this objective have to integrate digital technology in teaching and learning in such a way that all children are given opportunities to participate in work, life and society. It is thus of interest to study the extent of digital inclusion, by examining the variation in computer and information literacy of students both within and between schools by addressing access and use of ICT in instruction among teachers. Data for the present study comes from 138 schools from Norway (2436 students, 1653 teachers) and 110 schools from Denmark (1767 students, 728 teachers) who took part in the International Computer and Information Literacy Study in 2013. Using a multilevel approach, variations at both levels in student computer and information literacy score and teacher collaboration in ICT use were examined. The results indicate that availability of digital technologies is a significant contributor towards student ICT achievement and teacher collaboration in both countries. There are small differences in computer and literacy score between the schools, while significant variations are noted between the students. Additionally,

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teachers' attitudes are found to contribute significantly towards collaboration between teachers.

Keywords ICILS 2013 · Digital inclusion · Equity · Teacher collaboration · ICT resources · ICT use · Attitude

In light of digital inclusion, the successful and appropriate integration of information and communication technologies (ICT) in instruction has been acknowledged as a fundamental requirement across education systems worldwide. The manifestation of digital inclusion brings about equality/inclusion in strengthening the digital literacy required for educational achievement, future employment and social and economic development (Cha et al., 2011; Erstad, 2015; Livingston & Helsper, 2007; OECD, 2015). However, although digital inclusion keeps track of fast-changing and varied digital technologies, inclusion for all citizens still poses a challenge. This digital divide, which produces a participation gap, can be attributed to factors such as quality of ICT resources, extent of ICT usage, personal abilities/skills and variations in opportunities in terms of the frequency and complexity of tasks involving ICT (European Commission, 2013; Fraillon, Ainley, Schulz, Friedman, & Duckworth, 2019; Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014; Hawkins & Oblinger, 2006).

In the same manner, despite in-depth investments in ICT resources and better ICT access, ensuring that all students and teachers make ideal use of ICT remains a challenge for educators and authorities. Notable variations in ICT use and proficiency, attitudes towards ICT and levels of achievement are still visible in ICT research (Fraillon et al., 2014; Vanderlinde, Aesaert, & Van Braak, 2014). The current situation resonates with the concerns raised in the past two decades – that students may experience different access to ICT (Pedró, 2007) and that a digital divide could appear (Scheerder, van Deursen, & van Dijk, 2017). Digital divides are related to the socio-economic background and the cultural differences between students in addition to the variation in cultural conditions between schools concerning how ICT is used in teaching and learning. To some extent, schools can be expected to reduce the digital divide by trying to ensure that both students and teachers receive equal opportunities to acquire ICT skills and benefit from ICT integration and high-quality digital teaching materials in the subjects rather than by merely amassing more ICT resources in the school (Bremholm & Bundsgaard, 2019; Gorski, 2002). However, further research is required on this topic.

The integration of ICT in schools does not by itself lead to more innovative practices (Bundsgaard, Pettersson, & Puck, 2014; Cuban, 2013). To create a more innovative teaching practice, teachers need to change a number of aspects of their thinking about teaching and learning, their planning and organisation of teaching and learning and the roles of both themselves and the students in everyday

classroom practices. Following this line of thought, teacher collaboration is vital because new practices emerge and grow from teamwork, cooperation and networking (Fredriksson, Jedeskog, & Plomp, 2008).

In the last 10–20 years, there have been rapid changes related to digital technology, visible both in the education system and in society. This advent of digital components has posed some new difficulties and challenges to fulfilling the idea of 'School for All', which is one of the building blocks in the structure of the education system of the Nordic countries (Buchholtz, Stuart, & Frønes, 2020). The introduction of digital technologies to the education system has led to concerns regarding whether and to what extent this introduction could lead to a digital divide (Dybkjær & Christensen, 1994; Warschauer, 2002). Attempts to bridge the digital divide by providing massive ICT resources (Gorski, 2009) do not guarantee that students also experience mastery in digital technologies. Within the Nordic model, in contrast to digital equality (i.e. all students and schools receive the same resources), digital equity as a qualitative property concerning justice allows for the targeted distribution of technology and support so that no child is left behind. Digital equity involves giving all students equal access and opportunities to develop their holistic ICT proficiency both within and outside the classroom.

From a government policy view in the Nordic countries, high-level ICT investments in education have been made. The efforts also include a revision of the curricula in Nordic countries, in general, in a manner where digital competence encompasses not only the competent use of digital tools but also broader societal issues and critical aspects in digital inclusion (Krumsvik, 2008).

Inequities in terms of the opportunities that the students have to learn and achieve are to be counteracted by providing sound ICT infrastructure and high-quality teaching and learning. Concerning digital equity, ICT resources are equally distributed among schools in both Norway and Denmark. However, the information collected on the quality of the current ICT resources or on how well the teachers can use ICT resources in their own teaching is still limited.

Schools in both Norway and Denmark are entitled to national elementary funding for ICT integration towards fulfilling the goal of achieving digital equality in national policies. However, individual variations reflecting diversity have been noted in the number of resources installed in different municipalities, thereby creating some formal barriers or 'inequality' (Volckmar, 2019).

Although great efforts are put into increasing the levels of ICT infrastructure, the evidence in empirical research about the positive influences of ICT on teaching, learning or teachers' professional development is limited (Cox et al., 2003; Ward & Parr, 2010). Reiterating Espinoza's (2007) thoughts on addressing inequality with changing procedures, schools would benefit by equipping teachers with better digital skills so that they can transfer these skills as part of their own teaching. Moreover, research on ICT in schools supports the notion that ICT tools for communication, information and collaboration can aid in enhancing school outcomes and the effectiveness of both the teaching and personal learning of teachers (Kozma, 2009). As such, a large body of research has dealt with the specific ICT competencies needed by teachers in their role as educators (Pettersson, 2018). It is reasonable to say that

teachers play an essential role in ICT integration and the implementation of necessary technology tools in instruction (Davis, Eickelmann, & Zaka, 2013; Pettersson, 2018).

The International Computer and Information Literacy Study (ICILS), designed by the International Association for the Evaluation of Educational Achievement (IEA), has measured the international differences in students' computer and information literacy (CIL) in Grade 8 (or its national equivalent). ICILS, in addition to student achievement, has collected contextual information at the student, teacher and school levels. One of the findings in the ICILS 2013 noted that ICT use in lessons was rather limited in most participating countries, except Denmark, although teachers showed positive attitudes towards ICT in teaching (Fraillon et al., 2014). In terms of the pedagogical aspects of ICT, teachers face new demands on a regular basis in their pursuit of acquiring new skills and pedagogical practices. For instance, teachers' ICT use for communication and information-sharing purposes is instrumental in strengthening certain ICT skills and expertise, but this type of use alone is not automatically sufficient for integrating ICT in pedagogical practices; thus, ICT needs to be incorporated into teacher education and professional development (Hatlevik, 2017).

Norwegian and Danish schools aim for all students to have the opportunity to develop themselves and their abilities. ICT integration policies are not only directed towards institutional levels in terms of improving infrastructures and resources but also directed towards supporting ICT integration in instructional practices within the organisation. However, ensuring digital inclusion can be a dilemma if there are major differences in teachers' pedagogical usage of ICT technologies both within and between schools. As mentioned earlier, teachers significantly influence their students' opportunities for equality and the extent to which students can reach their individual potential and attain the highest possible outcomes.

In the current chapter, we focus on digital inclusion by assessing the differences between schools in Norway and Denmark in relation to factors such as teachers' access to ICT, their use of ICT in instruction and their attitudes towards ICT. The data for our study is obtained from the ICILS 2013 cycle, and we use this data to examine the traces of digital inclusion in Norwegian and Danish schools. We also try to connect the responses from teachers at the school to student outcomes.

6.1 Theoretical Background

6.1.1 Digital Inclusion and the Use of ICT in Teaching Practices

In today's digital society, having access to Internet services and ICT devices in addition to opportunities for training and support for ICT integration are considered as defining elements for being digitally competent. As defined in *Building the digitally*

inclusive framework for digitally inclusive communities, 'Digital inclusion is the ability of individuals and groups to access and use information and communication technologies (ICT)' (IMLS et al., 2011, p. 1). This definition is extended as 'digital inclusion encompasses not only access to Internet but also the availability of hardware and software; relevant content and services; and training for the digital literacy skills required for effective use of information and communication technologies' (p. 1). In other words, for a teacher to become digitally competent, they would require not only access to ICT in terms of both quantity and quality of resources but also to accumulate wide and effective experience in ICT use. Digital equity is yet another concept often understood as a part of the digital inclusion route towards goals set for enhancing social and economic equity (Gorski, 2002; OECD, 2015). In the earlier definitions of digital inclusion, the dichotomy of ICT users vs. ICT non-users concerning the digital divide was widely considered. For instance, inequalities regarding ICT access and use have been shown to be dependent on both age and socioeconomic status (SES) but not as much on gender (Livingston & Helsper, 2007). In fact, the understanding of digital inclusion in recent studies encompasses not only gradations in both access and use of ICT technologies but also the attitudes and motivations of ICT users (Robinson et al., 2015).

Education systems worldwide acknowledge that teachers are the cornerstone in schools and are responsible for system-wide implementation (Hargreaves & Fullan, 2012; Hattie, 2009). This encourages the widespread adoption of ICT in schools aimed at the development of ICT skills across the entire teaching profession. In general, the process of ICT integration is targeted through increased ICT resources, curriculum priorities and teachers' professional development in schools. Research, however, has shown mixed reports regarding the relationship between the availability of ICT resources, ICT implementation in instruction, teachers' attitudes and teachers' professional development (Fraillon et al., 2014, 2019). Several studies have focused on teachers' pedagogical use of digital technologies in teaching and instruction (González-Sanmamed, Sangrà, & Muñoz-Carril, 2017; Prestridge, 2017) and the multidimensionality of ICT use in the classroom (Donnelly, McGarr, & O'Reilly, 2011). The results have highlighted a common characteristic among many European countries: Teachers seem to demonstrate a rather modest use of ICT for teaching purposes (Gill, Dalgarno, & Carlson, 2015; Haydn, 2014; Tondeur et al., 2015; Wastiau et al., 2013). In contrast, differences between European countries have also been noted. For example, Danish teachers report more frequent ICT use in teaching than Norwegian teachers or teachers from other countries (Fraillon et al., 2014). Recent research also reports differences between teachers regarding their attitudes towards ICT and what they believe about successful ICT use as part of their teaching practices (Haydn, 2014). Investments have been made in infrastructure, but these are insufficient. Providing training for selected teachers is necessary so that these teachers can be local supports for their colleagues.

6.1.2 Digital Equality and Teacher Collaboration

Equality, according to Corson (2001), implies sameness in general treatment. The concept of 'equality for all' mirrors that of equality of opportunity for all with the goal of ensuring that all individuals have the same amount of, and access to, resources without any political, legal, economic or social constraints (Espinoza, 2007). Using educational attainment as the output angle in light of digital inclusion, 'equality' means that all teachers have the same opportunities to use and master digital technology. In addition, equality means that each student receives the same opportunity to obtain the highest possible individual outcome (Ainscow & Miles, 2008; Espinoza, 2007). The digital divide highlights the opposite of digital equality in educational opportunities for all students, making it even more important to ensure digital equality in schools. Regarding teachers, this includes eliminating inequities as they attempt to learn to effectively use ICT coupled with the provision of access to ICT resources.

The equal distribution of ICT resources and other infrastructures represents a quantitative level of equality, whereas the concept of equity can be understood as the qualitative factor of providing 'just opportunities' for enhancing ICT competence and improving school outcomes (Espinoza, 2007). As part of the compensatory approach towards school effectiveness, it can be argued that teachers who collaborate in their ICT use not only improve their competence and ICT self-efficacy but also compensate for a lack of well-distributed resources or compensate for individual student characteristics (e.g. learning challenge) in their endeavour for equity. In other words, each student should benefit from a teacher possessing better ICT skills as part of within-school factors concerning policies and practices (Ainscow, Dyson, Goldrick, & West, 2016). Ainscow et al. (2016) further elaborated that 'the starting point for strengthening the capacity of a school to respond to learner diversity should be with the sharing of existing practices through collaboration amongst staff and joint practice development' (p. 149). Through this 'just distribution' of developing ICT skills in students and teachers, propositions of achieving equity can be envisaged.

Collaboration between teachers can facilitate the exploitation of both existing and new technologies in instructional practices and is an efficient tool for professional development (Bacigalupo & Cachia, 2011; Fogarty & Pete, 2010; McCormick, 2004). In addition to cultivating ICT use among their students as part of new literacy frameworks, teachers are regularly the 'learners' of new ICT and related tasks. Importantly, the precursor for optimal ICT implementation is when teachers experience a personal need for using ICT and feel digitally competent in their ability to effectively use ICT in instructional practice (Ward & Parr, 2010). In-house training and adoption of ICT-related practices within schools contribute to the development of teachers' own ICT competence and support the improvement of a student-oriented pedagogical approach (Drent & Meelissen, 2008; Egeberg et al., 2012; Fraillon et al., 2014; Wang, Hsu, Reeves, & Coster, 2014). However, the situation is dependent upon how much ICT is used in terms of time and access and upon how

well it is implemented as part of within-school teacher collaboration (Chapman & Fullan, 2007; Lindqvist, 2015).

6.1.3 Computer and Information Literacy (CIL)

Various terms are used to describe students' digital capabilities (Ala-Mutka, 2011) – for example, digital competence (Calvani, Fini, Ranieri, & Picci, 2012), ICT literacy (Erstad, 2006), digital literacy (Mioduser, Nachmias, & Forkosh-Baruch, 2008), CIL (Fraillon et al., 2014), twenty-first century skills (Binkley et al., 2012) and digital skills (Zhong, 2011). These terms describe successful ICT use as an independent and transversal learning area in addition to traditional subjects. They also encompass the combination of certain aspects of digital technologies (e.g. ICT, Internet and computer information) and the capability to benefit from the adopting digital technologies (e.g. skill, competence and literacy; Ferrari, 2012).

In the ICILS 2013 assessment framework, CIL is defined as the ability 'to use computers to investigate, create, and communicate in order to participate effectively' in various areas of life (Fraillon, Schulz, & Ainley, 2013, p. 17). Further, CIL is characterised by two overarching strands that are divided into seven content categories. Strand one is entitled *collecting and managing information*. This strand includes a practical understanding of how to use a computer and the capability to find and critically evaluate online information. Strand two of the framework, entitled *producing and exchanging information*, deals with the aspects of participating, producing and publishing using a computer as a tool. This strand comprises communication, safe use of information, secure use of information and transforming and creating digital information.

6.1.4 The Context of ICT in Norway and Denmark

Digital technology and digital inclusion have been on Norway's national education agenda for many years. At the end of the 1980s, ICT entered Norwegian secondary schools as an elective subject, and since the mid-1990s, national plans have included ICT in schools (Erstad, Kløvstad, Kristiansen, & Søby, 2005). There was also a focus on technology in the plan from 1996–1999 (Ministry of Education and Research, later in text MER, 1996), which included sub-areas such as 'learn to use', technical infrastructure, organisation and teacher education. Further, the national plan for 2000–2003 emphasised the educational use of ICT in schools (MER, 2000). During 2004–2008, the national ambition was to develop the digital competence of students and teachers (MER, 2004). This program overlapped with a curriculum reform, as the capability to use digital tools and resources was one of the five basic competence areas for all students (MER, 2006). In 2012, a framework outlining four areas of competence – *search and process*, *produce*, *communicate* and *digital*

responsibility – for digital skills was presented (The Norwegian Directorate for Education and Training, 2012). These four areas form the fundamental aspects of digital competence that teachers are expected to incorporate into their teaching to facilitate ICT literacy and ensure digital inclusion. As an equity aspect of the national educational plan, the policies state that every student should receive the same opportunity in a uniform school system. Nevertheless, the pedagogical use of ICT for teaching and learning varies between and within schools (Hatlevik & Christophersen, 2013; Hatlevik & Gudmundsdottir, 2013; Hatlevik, Guðmundsdóttir & Loi, 2015).

In Denmark, the integration of ICT in education has been on the national agenda for many years (Caeli & Bundsgaard, 2019). In the 1960s, the first Danish professor of computer science, Peter Naur, spoke in favour of creating a subject with a focus on both the critical understanding of the role of computers in society and the practical skills in the development of computer systems. In the 1970s, a subject was envisioned and ready to be introduced in schools, but a shift in the government stopped it. A similar subject was taught as an elective in the 1980s, computers were acquired, and numerous experiments using computers in teaching and learning were performed. In the 1990s, many government-initiated projects and experiments were conducted, the first wave of broad acquisition of hardware for schools took place, and schools began to become connected to the Internet through the so-called Sektornet, which was owned and maintained by the Ministry of Education until 2014 and provided connection to the Internet for educational institutions in Denmark. In the 2000s, a government funding scheme called ICT and Media in the Public Schools (ITMF or *IT og medier i Folkeskolen* in Danish) resulted in many local research and development projects concerning integrating ICT in teaching and learning. At the same time, massive investments were made in hardware, especially laptops for students and teachers and interactive whiteboards. Around 2010, the government funded laptops for all students in Grade 3 and supported the development of digital learning platforms that were expected to cover complete subjects. In particular, many municipalities and schools began investing in tablets (mostly iPads) for the students and teachers. From 2012 to 2017, the government and the Association of the Municipalities agreed to support the development of learning management platforms among other things. Schools were provided with funding for the acquisition of learning materials, with 50% of the expenses paving the way for the massive development of ICT and leading to the widespread use of ICT in everyday teaching and learning (Bremholm & Bundsgaard, 2019; Bundsgaard, Bindslev, Caeli, Pettersson, & Rusmann, 2019).

6.1.5 The Present Study

Under the broad definition of digital inclusion, this study addresses the diversity in teachers' use, access and attitudes towards ICT. To our knowledge, the assessment of variations in teacher variables in Norway and Denmark using a comparative

analysis approach is rather limited. Previous research has indicated that school-level characteristics, such as school ICT infrastructure/resources and policies related to ICT use, influence the extent to which teachers promote ICT integration in instruction. Moreover, teachers' positive attitudes towards ICT use and their ability to provide support to and receive support from colleagues are highlighted as important in the literature. Keeping this background in mind, we posited four hypotheses (H1–H4) in our study.

The first hypothesis (H1) relates to the variation in teachers' access to ICT, their use of ICT and their ICT attitudes:

H1 In both Norway and Denmark, there is variation between schools concerning teachers' self-reported ICT access, ICT use and ICT attitudes.

It is important that teachers experience equal opportunities to develop their ICT competence. Prior results have shown a positive association between school ICT resources and ICT integration (Fraillon et al., 2014, 2019). However, despite the availability of all-encompassing ICT resources, teachers' backgrounds (e.g. gender and age) play a central role in ensuring successful ICT implementation.

The second hypothesis (H2) aims to study the variation between teachers' background variables, their attitudes and their collaborative practices:

H2 Teachers' backgrounds and their ICT experiences, including a perceived lack of resources, can explain the variation in their teaching with ICT, their self-efficacy, their emphasis on developing ICT capabilities and their collaboration using ICT.

Collaboration between teachers using ICT is an essential characteristic of successful ICT use for teaching purposes. Furthermore, ICT resources play an important role in enhancing collaboration. Thus, our third hypothesis (H3) states the following:

H3 Teachers' backgrounds, ICT resources, ICT use and attitude variables (self-efficacy and views about ICT use) predict their collaboration with colleagues in the use of ICT.

Finally, to our knowledge, few studies have examined what teachers report about their ICT practices in relation to the digital achievement of the students. One could assume a positive relationship between what the teachers do and think on the one hand and the digital proficiency of the students on the other. This led to our fourth hypothesis (H4):

H4 Teachers' ICT use, attitudes towards ICT and perceived collaboration with colleagues predict variation in students' CIL.

6.2 Methods

6.2.1 International Computer and Information Literacy Study (ICILS) 2013

The ICILS 2013 collected data from both students and teachers across 21 participating education systems (Fraillon et al., 2013, 2014). A stratified two-stage probability cluster sampling design was used for school sample selection for all ICILS countries (Meinck, 2015). Both the students and teachers were randomly sampled from the selected schools, and the students participated in a CIL test in a computer-based environment in addition to completing a self-report questionnaire (including information about the students' background). For each student, only a subset of CIL items from a larger pool was administered to compensate for time constraints, with the intention of measuring students' broad CIL.

The ICILS assesses students' CIL using a purpose-designed computer-based test environment. The test comprises tasks (with many small tasks and one large task in each module) based on real-life themes. A proficiency scale describing four competence levels was developed based on a synthesis of typical elements of CIL content and item difficulties. Item Response theory was used to pair the scaled difficulty of each item with the item descriptor (Fraillon et al., 2014, p. 72). To estimate the standard errors possible for the derived statistical procedures (e.g. regression analysis), a plausible value method was used to derive five probable CIL achievement scores for each student, which were imputed based on the estimated latent student ability and responses to the background questionnaire. The ICILS 2013 data has been made publicly available by the IEA.[1]

Teacher participation in the study was voluntary. Teachers received a link to an online self-report questionnaire designed to be answered in about 30 min. For some questions, the teachers were asked to respond to the items about their background along with their views and attitudes in relation to a randomly selected reference class.

6.2.2 Study Sample

Data for the present study were obtained from the Norwegian and Danish samples. Both education systems are guided by the ambition for equalisation, for equal opportunities and that the school can counteract digital diversity among the students. In Norway, the sample comprised 2436 students and 1653 teachers in 138 schools; in Denmark, 1767 students and 728 teachers from 110 schools formed our sample. Because many teachers did not respond to all items, overall, samples

[1] https://www.iea.nl/data-tools/repository

comprising 1183 teachers in Norway and 722 teachers in Denmark were included in our analysis. The Norwegian sample comprised 63% female and 37% male participants, whereas 59% female and 41% male participants were included in the Danish sample. The teachers in Norway and Denmark were teaching two or more subjects. The majority of the teachers in Norway (68%) and Denmark (81%) taught test language or a foreign language subject.

6.2.3 Measures

To address our hypotheses, we used several constructs from the teacher data file, whereas the student CIL scores were obtained from the student data file. Teacher gender (coded as 0 for male and 1 for female), teacher age in actual years and teacher experience with ICT (T_EXPT) were used as background questions. Three options – 'Never' as (1), 'Fewer than two years' as (2) and 'Two years or more' as (3) – were used to code for how long the teachers had been using computers for teaching purposes. In questions related to ICT, teachers' ICT use, attitudes and views, the individual indices were scaled using IRT and Warm's weighted likelihood estimates (WLE). The scales presented in Table 6.1 were transformed to a mean of 50 points and a standard deviation of 10 points across participating countries. For details on the measures and scaling procedures, we kindly refer to Fraillon, Schulz, Friedman, Ainley, and Gebhardt (2015), Schulz and Ainley (2015) and Schulz and Friedman (2015).

6.2.4 Analytical Approaches

The information about variation between schools was extracted using the intraclass correlation (ICC; Geiser, 2012; Hox, 2013). The ICC provides a measure of between-school variation (how similar the groups are) in the outcome that is accounted for by the schools (McCoach & Adelson, 2010). In addition, we used multiple regression techniques to investigate the relative strengths of the association of the factors and multilevel structural equation modelling (SEM) on our data.

All analyses were conducted in the statistical package M*plus* 8.3 (Muthén & Muthén, 1998–2015). School identity was used as the cluster variable, and total teacher weight (TOTWGTT) was used in the M*plus* option for WEIGHT. To evaluate the fit of the structural equation models, common guidelines were applied (i.e. CFI $\geq$ .95, TLI $\geq$ .95, RMSEA $\leq$ .08 and SRMR $\leq$ .10) for an acceptable model fit (Marsh, Hau, & Grayson, 2005). The problem of missing data was resolved by data imputation. M*plus* uses multiple imputation (MI) for missing data using the full information maximum likelihood (FIML) approach. We used the robust maximum likelihood estimation (MLR), which accounted for the clustering of students in schools by correcting the standard errors in M*plus*.

Table 6.1 Measures from the ICILS 2013 used for the current study

Scale	# Items	Item stimulus	Item example	Response categories
Teachers' use of specific ICT applications. (T_USEAPP)	*14*	Use of ICT practices and activities in their teaching in their reference class.	'Word processors or presentation software'	4-point scale (from 'never' to 'in every or almost every lesson')
Teachers' use of ICT for learning at school. (T_USELRN)	*13*	Use of ICT for learning at school.	'Working on short assignments (i.e. within one week)'	3-point scale (from 'never' to 'often')
Teachers' use of ICT for teaching practices at school. (T_USETCH)	*11*	Use of ICT in a set of teaching practices.	'Presenting information through direct class instruction'	3-point scale (from 'never' to 'often')
Teachers' ICT self-efficacy. (T_EFF)	*14*	How confident they felt in diverse ICT-related tasks by themselves.	'Producing a letter using a word-processing program'	3-point scale ('I know how to do this', 'I could work out how to do this' and 'I do not think I could do this')
Teachers' emphasis on teaching ICT skills. (T_EMPH)	*12*	Emphasising the development of ICT-based capabilities in students in their reference class.	'Accessing information efficiently'	4-point scale (from 'strong emphasis' to 'no emphasis')
Teachers' positive views on using ICT in teaching and learning. (T_ VWPOS)	*8*	Views on the positive outcomes of using ICT in teaching and learning.	'Enables students to access better sources of information'	4-point scale (from 'strongly agree' to 'strongly disagree')
Teachers' negative views on using ICT in teaching and learning. (T_ VWNEG)	*7*	Views on the adverse outcomes of using ICT in teaching and learning.	'Only encourages copying material from published internet sources'	4-point scale (from 'strongly agree' to 'strongly disagree')
Teachers' perspectives on the lack of computer resources in school. (T_RESRC)	*6*	Perceptions on the lack of computer resources in school.	'My school does not have sufficient ICT equipment (e.g. computers)'	4-point scale (from 'strongly agree' to 'strongly disagree')
Collaboration between teachers in using ICT. (T_COLICT)	*6*	Perceptions on the collaborative practices with ICT use during teaching.	'I systematically collaborate with colleagues to develop ICT-based lessons based on the curriculum'	4-point scale (from 'strongly agree' to 'strongly disagree')

(continued)

Table 6.1 (continued)

Scale	# Items	Item stimulus	Item example	Response categories
CIL-achievement score (in plausible value (PV)).	*5*	CIL scores in ICILS 2013 had a mean of 500 points and a standard deviation of 100 points.	PV1CIL to PV5CIL (5 likely CIL proficiencies for students that attained each score)	

Note. Higher index values indicate higher frequency of use or higher levels of collaboration, except in the case of T_VWNEG and T_RESRC. See the supplementary material for details

6.3 Results

Based on our theoretical assumptions, we introduced four hypotheses regarding the use of ICT in school instruction and teacher collaboration. In this section, we first present the descriptive statistics highlighting the characteristics of the variables used in this study (Table 6.2), particularly reliability (Cronbach's alpha), indicating the internal consistency between the items in a scale. In the second section (Tables 6.3, 6.4, 6.5, and 6.6), the results of successive analyses are presented. Table 6.5 presents the results of the multiple regression analyses with collaboration as the dependent variable, addressing H3, whereas Table 6.6 presents the results of the multiple regression analysis with CIL as the dependent variable, addressing H4.

6.3.1 Summary of Scale Reliabilities, the Means and Standard Deviations

The reliabilities of the scales and descriptive statistics of the constructs in our study were examined before proceeding with other analyses. Regarding the scales' reliability (Table 6.2), almost all scales showed acceptable values above 0.80. Given that the means and standard deviations were internationally set at $M = 50$ and $SD = 10$, respectively, the Norwegian and Danish data do not show ceiling or floor effects.

6.3.2 Variation in Teachers' Self-Reported ICT Access, ICT Use and Their Attitudes (H1)

To study the variation between schools, ICC values were generated for the variables of concern in our study. Table 6.3 presents the results for the two countries.

Higher ICC values indicate a high degree of heterogeneity between schools (Geiser, 2012). In our results, the ICC values were low (ICC < 0.05) for the majority

Table 6.2 Scale Reliabilities and Descriptive Statistics for the Variables in Norway and Denmark

	Norway			Denmark		
Variables	α	*M*	*SD*	α	*M*	*SD*
Teachers' experience in using ICT for teaching purposes (T_EXPT)	–	1.92	0.30	–	1.95	0.22
Teachers' perspectives on the lack of computer resources (T_RESRC)	0.79	51.35	8.18	0.80	50.91	8.62
Teachers' perspectives on collaboration between teachers in using ICT (T_COLICT)	0.71	44.78	7.83	0.76	45.37	9.01
Teachers' use of ICT applications in teaching (T_USEAPP)	0.81	50.52	6.66	0.86	53.07	6.95
Teachers' use of ICT for learning at school (T_USELRN)	0.81	52.24	7.40	0.86	54.67	7.19
Teachers' use of ICT for teaching at school (T_USETCH)	0.89	51.21	7.49	0.89	53.56	7.51
Teachers' perceived self-efficacy in using ICT at school (T_EFF)	0.83	51.57	8.17	0.82	53.26	7.86
Teachers' emphasis on developing ICT-based capabilities (T_EMPH)	0.95	51.33	7.52	0.96	52.76	7.58
Teachers' positive views on using ICT in teaching and learning (T_VWPOS)	0.81	49.28	8.19	0.82	51.13	8.62
Teachers' negative views on using ICT in teaching and learning (T_VWNEG)	0.78	43.92	9.32	0.77	42.14	10.01

Note. T_EXPT is not used as a scale. All other scales are WLE = weighted mean likelihood estimate (Warm, 1989). SD = standard deviation, α = Cronbach's alpha

Table 6.3 Intraclass Correlation (ICC) for Teachers' Self-reported ICT Access, ICT Use and their ICT Attitudes in Norway and Denmark

	Norway	Denmark
Variables	ICC	ICC
Teachers' experience in using ICT for teaching purposes (T_EXPT)	0.018	0.012
Teachers' perspectives on the lack of computer resources (T_RESRC)	0.280*	0.307*
Teachers' perspectives on collaboration between teachers in using ICT (T_COLICT)	0.090*	0.103*
Teachers' use of ICT applications in teaching (T_USEAPP)	0.018	0.072
Teachers' use of ICT for learning at school (T_USELRN)	0.057	0.060
Teachers' use of ICT for teaching at school (T_USETCH)	0.055	0.080
Teachers' perceived self-efficacy in using ICT at school (T_EFF)	0.007	0.043
Teachers' emphasis on developing ICT-based capabilities (T_EMPH)	0.011	0.047
Teachers' positive views on using ICT in teaching and learning (T_VWPOS)	0.020	0.026
Teachers' negative views on using ICT in teaching and learning (T_VWNEG)	0.033	0.038

Note. *$p < .05$, **$p < .01$

Table 6.4 Explained variance in different constructs using teachers' gender, age, experience with ICT and perceived lack of ICT resources for various purposes, attitudes and collaboration

	Norway	Denmark
	Beta (SE)	Beta (SE)
Teachers' use of ICT for learning at school		
Intercept	*6.62 (0.34)***	*0.97 (0.02)***
Gender	0.01 (0.04)	0.03 (0.05)
Age	−0.13 (0.03)**	0.03 (0.04)
Experience	0.19 (0.04)**	0.11 (0.05)*
Perceived lack of resources	−0.05 (0.05)	−0.13 (0.04)**
R-SQUARE	0.05 (0.02)	0.03 (0.02)*
Teachers' use of ICT applications in teaching		
Intercept	*6.91 (0.43)***	*7.33 (0.55)***
Gender	−0.02 (0.04)	−0.06 (0.05)
Age	−0.14 (0.03)**	0.02 (0.04)
Experience	0.21 (0.04)**	0.12 (0.04)**
Perceived lack of resources	−0.02 (0.05)	−0.13 (0.04)**
R-SQUARE	0.05 (0.02)**	0.04 (0.02)*
Teachers' use of ICT for teaching at school		
Intercept	*6.53 (0.41)*	*7.32 (0.47)***
Gender	0.05 (0.04)	0.01 (0.05)
Age	−0.15 (0.03)**	−0.03 (0.05)
Experience	0.18 (0.03)**	0.10 (0.04)*
Perceived lack of resources	−0.05 (0.05)	−0.16 (0.04)**
R-SQUARE	0.05 (0.01)*	0.03 (0.01)*
Teachers' perceived self-efficacy in using ICT at school		
Intercept	*7.86 (0.29)*	*7.49 (0.48)***
Gender	−0.10 (0.04)**	−0.29 (0.04)**
Age	−0.45 (0.04)**	−0.18 (0.04)**
Experience	0.10 (0.03)**	0.12 (0.03)**
Perceived lack of resources	−0.05 (0.03)	0.11 (0.05)*
R-SQUARE	0.20 (0.04)**	0.13 (0.03)**
Teachers' emphasis on developing ICT-based capabilities		
Intercept	*6.374 (0.31)***	*6.589 (0.60)***
Gender	0.13 (0.04)**	0.03 (0.04)
Age	−0.10 (0.03)**	0.07 (0.04)
Experience	0.167 (0.03)**	0.06 (0.04)
Perceived lack of resources	−0.057 (0.09)	−0.10 (0.04)**
R-SQUARE	0.05 (0.01)**	0.19 (0.01)
Teachers' views on collaboration between teachers		
Intercept	*7.13 (0.30)***	*6.55 (0.49)***
Gender	−0.00 (0.03)	0.08 (0.04)*
Age	0.07 (0.03)	0.08 (0.05)
Experience	0.05 (0.03)	0.05 (0.04)
Perceived lack of resources	−0.31 (0.04)**	−0.38 (0.04)**
R-SQUARE	0.11 (0.02)*	0.16 (0.03)**

Note. *$p < .05$, **$p < .01$

Table 6.5 Variations in teachers' views on collaboration in using ICT

	Norway	Denmark
	Beta (SE)	Beta (SE)
Intercept (collaboration in using ICT)	*4.37 (0.54)*	*6.55 (0.49)***
Gender of teacher	−0.03 (0.03)	−0.05 (0.04)
Age of teacher	0.14 (0.04)**	0.08 (0.04)
Teacher experience with ICT	−0.01 (0.03)	0.01 (0.03)
Perceived lack of resources (ICT)	−0.26 (0.03)**	−0.33 (0.04)**
Teachers' use of ICT applications in teaching	−0.08 (0.06)	0.06 (0.09)
Teachers' use of ICT for learning at school	−0.02 (0.07)	0.13 (0.08)
Teachers' use of ICT for teaching at school	0.27 (0.09)**	−0.01 (0.08)
Teachers' perceived self-efficacy in using ICT at school	0.04 (0.04)	0.08 (0.04)
Teachers' emphasis on developing ICT-based capabilities	0.05 (0.07)	0.05 (0.06)
Teachers' positive views on using ICT in teaching and learning	0.15 (0.04)**	0.28 (0.05)**
Teachers' negative views on using ICT in teaching and learning	−0.01 (0.04)	0.13 (0.05)*
R-SQUARE	0.20 (0.03)**	0.31 (0.04)**

Note. *$p < .05$, **$p < .01$

Table 6.6 Multiple regressions with CIL as the dependent variable

	Norway	Denmark
	Beta (SE)	Beta (SE)
Intercept (students' CIL score)	*20.39 (2.0)***	*18.49 (1.6)***
Gender of teacher	−0.02 (0.06)	−0.04 (0.05)
Age of teacher	0.06 (0.05)	0.10 (0.06)
Teacher experience with ICT	−0.02 (0.07)	−0.01 (0.04)
Perceived lack of resources (ICT)	−0.20 (0.08)*	−0.14 (0.07)*
Teachers' use of ICT applications in teaching	−0.21 (0.14)	−0.23 (0.11)*
Teachers' use of ICT for learning at school	0.19 (0.15)	0.30 (0.13)*
Teachers' use of ICT for teaching at school	0.06 (0.13)	0.09 (0.11)
Teachers' perceived self-efficacy in using ICT at school	−0.01 (0.06)	0.06 (0.07)
Teachers' emphasis on developing ICT-based capabilities	−0.08 (0.13)	−0.15 (0.11)
Teachers' positive views on using ICT in teaching and learning	−0.01 (0.08)	−0.02 (0.05)
Teachers' negative views on using ICT in teaching and learning	0.10 (0.06)	−0.04 (0.06)
Teachers' perspectives on collaboration between teachers in using ICT	−0.10 (0.08)	−0.08 (0.06)
R-SQUARE	0.06 (0.03)*	0.065 (0.03)

Note. * $p < .05$, ** $p < .01$

of the measures of access to ICT, use of ICT and ICT attitudes in both countries (see Table 6.2). This means that our assumption about variation in access, use, and attitudes did not hold true for use and attitude.

There were, however, some exceptions, revealing that the assumptions in H1 were valid for the lack of ICT resources and collaboration. In both Norway and Denmark, variations were found in teachers' views on the lack of ICT resources between schools (ICC = 0.28 and ICC = 0.307, respectively), indicating that almost

30% of the variation for this construct was found between schools. Variation between schools for the construct regarding views on teacher collaboration in using ICT was approximately 10% (ICC = 0.09 and ICC = 0.103, respectively).

Further, the ICC values from the Norwegian sample were slightly above 0.05 for the variables use of ICT for learning and use of ICT for teaching. In Denmark, the ICC values were between 0.06 and 0.08 for the variables use of ICT application, use of ICT for learning and use of ICT for teaching. This shows little variation across schools, which does not support H1. The small amount of variation between schools can be considered a problem for our statistical analyses. However, from the equity perspective, less variation between schools contradicts H1, and this can be used as an argument to support the claim of high degrees of equality between schools.

6.3.3 Variation in Teacher Self-Efficacy, Developing ICT Capabilities and Their Collaboration (H2)

In an attempt to study equality in teachers' experiences and collaborative practices in the frame of ICT, H2 addressed variations in teachers' teaching with ICT, their ICT self-efficacy, their collaboration with other teachers in using ICT and their emphasis on developing ICT-based capabilities using background variables in regression analyses. Table 6.4 presents the results for the two countries in terms of the beta values and standard errors.

In Norway, both age and experience with ICT showed a significant contribution to variation in the three different uses of ICT constructs (Table 6.4). However, the levels of explained variations were low (around 5%). Meanwhile, in Denmark, teachers' experience with ICT and their perceptions of the lack of ICT resources seemed to contribute to variation in the use of ICT for teaching at school. Regarding teacher self-efficacy, in both Norway and Denmark, gender (being male), age (being younger) and more experience with ICT significantly contributed to variation in teacher self-efficacy. Furthermore, in Denmark, teachers' perceptions of the lack of ICT resources seemed to have contributed to diversification. The explained variation was 20% in Norway and 13% in Denmark. Gender (being male), age (being younger) and more experience with ICT were also significant contributors to variations in teachers' emphasis on developing ICT-based capabilities in Norway. In contrast, in Denmark, only the perceived lack of ICT resources significantly contributed to the variance. The explained variance was 5% in Norway and 19% in Denmark.

While examining teachers' views on collaboration practices in ICT use, age and experience with ICT were not found to be significant predictors. Gender showed a weak contribution in the case of Denmark. Overall, teachers' views on the lack of ICT resources were a significant contributor in both Norway and Denmark. The explained variation was 11% in Norway and 16% in Denmark.

In both countries, H2 held for teachers' perceived self-efficacy in using ICT at school and teachers' views on collaboration between teachers. H2 also held for Danish teachers' emphasis on developing ICT-based capabilities, meaning that H2

did not have support when examining variation in teachers' use of ICT for learning at school, teachers' use of ICT applications in teaching and teachers' use of ICT for teaching at school.

6.3.4 Teacher Collaboration Predicts ICT Use and Teachers' Positive Views (H3)

Multiple regression analyses with collaboration as the dependent variable for the two countries were individually performed. The results are displayed in Table 6.5. All independent variables were simultaneously entered into the regression.

As seen in Table 6.5, no regular patterns were visible among the predictors for collaboration between teachers in either country. However, the perceived lack of ICT resources at school and teachers' positive views (for ICT use in instruction) played a significant role and had a relatively stable predictive power for teacher collaboration in both countries. The standardised regression coefficient weights in the case of Denmark were higher than those in the case of Norway for perceived lack of resources ($\beta = -0.26$ vs. $\beta = -0.33$) and teachers' positive views ($\beta = 0.15$ vs. $\beta = 0.28$). These fell into the medium effect size category (Cohen, 1988).

The age of the teacher ($\beta = 0.14$) and the use of ICT for teaching at school ($\beta = 0.27$) were significant contributors to the explained variance in Norway. In addition, teachers' negative views on using ICT in teaching and learning were substantial contributors in the case of Denmark ($\beta = 0.15$). The indicators under consideration provided different explanations, as reflected by the explained variances of the regression model. The model for Norway explained 20% of the variance compared with the model for Denmark, which had a variance of 31%. These findings support the assumption in H3 that there are variables and concepts that can explain the variance in teachers' collaboration using ICT.

6.3.5 Variation in CIL Score Using Teacher Variables (H4)

In our attempt to explain the variation in students' CIL scores using teacher variables through H4, were aggregated at the school level in this analysis. The results of the regression analyses for the two countries, with CIL score as the dependent variable and where the independent variables were simultaneously entered, are presented in Table 6.6 in terms of the beta values and their standard errors.

Overall, significant results ($p < 0.05$) were observed only for teachers' perceived lack of resources in both countries. The standardised regression coefficient weights in Norway were higher than those in Denmark for perceived lack of resources ($\beta = -0.20$ vs. $\beta = -0.14$). Two use variables, teachers' use of ICT applications in teaching and teachers' use of ICT for learning at school, contributed to the explained

variance in Denmark with values of $\beta = -0.23$ and $\beta = 0.30$, respectively. Concerning these two beta values, providing a clear explanation of why one was positive and the other was negative is difficult.

All the other regression coefficients were not statistically significant, leaving us with a low value of the explained variation in the CIL scores in both countries. From an equality perspective, we have identified variation in the CIL scores on the individual level; however, it does not seem that the difference between teachers' use of ICT and attitudes can explain sufficient variation. Another way to interpret this finding is that 'use of ICT' alone by teachers in a school does not necessarily lead to equality. Overall, these results do not support the assumption in H4 that teachers' use of ICT, their attitudes and perceived collaboration with colleagues can explain the variation in students' CIL scores. Although the results do not indicate that some schools work better with ICT than other schools in digital inclusion, this does not exclude that contextual and individual factors within the schools are important for equality and that all students have the opportunity to develop.

6.4 Discussion

The ICILS 2013 provides us with in-depth information on the factors related to ICT development at multiple levels along with international comparisons. The present contribution aims at highlighting the manner in which schools in the two Nordic countries are trying to bridge the achievement gaps within the frame of the respective ICT integration policies. We can draw several theoretically and practically important conclusions from our analyses using student achievement and teacher data (ICILS 2013) from Norway and Denmark. Concerning teachers' access to ICT, their use of ICT in instruction and their attitudes towards ICT at the school level, our study found no significant variation between the schools in Norway and Denmark. There was also no significant variation in teachers' use of ICT (application in teaching/for learning/for teaching at school). As one of our main findings, this lack of variation between schools seems to be an indicator of digital equality at the institutional level. The lack of variation between schools in these teacher variables, however, does not imply that no variation exists within the schools regarding teachers' access and use of ICT. Our subsequent findings suggest a particular structure of digital divide in Norwegian and Danish schools, and this inequality could be further highlighted by analysing the differences within schools and between individuals. In both Norway and Denmark, ICT is integrated as a learning dimension in all subjects, but it is up to the individual schools to implement the necessary practices for ICT integration. Irrespective of the local choices made, these practices are loyal to the national objectives.

Teachers' understanding of the initiatives taken by authorities, along with the concepts used to describe and assess student ability to use and succeed in using ICT (e.g. CIL, ICT literacy and digital competence), is multidimensional (Aesaert & van Braak, 2014). Thus, considering this multidimensionality, teachers might be

influenced while responding to the questionnaire items about the usefulness of ICT (Scherer, Siddiq, & Teo, 2015). In H1, we attempted to address the variation in teachers' views on the lack of ICT resources. Interestingly, variation was observed in teachers' views on the lack of ICT resources and teachers' collaboration between schools. ICT resources are presumed to be necessary for creating advantages in both student outcomes and staff attitudes (European Commission, 2013). Despite the high level of government ICT investments in education in both countries, some unequal distribution of these resources exists owing to geographical and other formal barriers (Volckmar, 2019). One explanation may be the local authority and responsibility for making the right choices and the priorities within the individual municipality and school. At the school level, the immediate responsibility for resource allocation and implementation of policies lies with the school staff. This implies that access to not only resources but also relevant knowledge is a prerequisite for schools attempting to achieve equity. Teachers who have reached a sufficient level of ICT self-efficacy are more likely to implement ICT into their teaching practices (Hatlevik, 2017). Teachers' personal ICT competence and attitudes (perceptions of their ICT skills) towards successful ICT implementation in instruction are strong predictors of their ICT use in teaching (Albion, Tondeur, Forkosh-Baruch, & Peeraer, 2015; Davis et al., 2013; Gerick, Eickelmann, & Bos, 2017; Ward & Parr, 2010).

In testing H2, we observed variation between schools in terms of teachers' collaborative practices. In both countries, there seemed to be less teacher collaboration with ICT use in schools where the teachers perceived a lack of ICT equipment and resources. When it comes to H2, the analyses revealed a more nuanced relationship. H2 did not hold when explaining the sufficient levels of variation in teachers' use of ICT for learning at school, teachers' use of ICT applications in teaching and teachers' use of ICT for teaching at school. However, the results for Denmark showed that teachers' backgrounds and their experience with ICT can explain variations in teachers' emphasis on developing ICT-based capabilities. Overall, the results showed that teachers' backgrounds and experience with ICT can explain the variations in their perceived self-efficacy and their views on collaboration between teachers. One way to interpret this is that there are no traces of inequality in teachers' use of ICT, but there are traces of digital inequality between teachers when it comes to their self-efficacy and views on collaboration. It certainly is important for teachers to gain experience with ICT to learn how to use ICT in general and to use ICT to teach and learn.

Gender was found to be a predictor of teachers' attitudes, which aligns with earlier research indicating that male teachers have higher ICT self-efficacy (Scherer et al., 2015; Wikan & Molster, 2011). Gender (being male; e.g. Broos, 2005), age (being younger) and more experience with ICT were also significant contributors to variations in teachers' emphasis on developing ICT-based capabilities in schools in Norway, thereby creating a slighter different profile from that of Denmark. A negative relation between teachers' age and perceptions of usefulness has also been noted in earlier studies (e.g. O'bannon & Thomas, 2014; Scherer et al., 2015; Vanderlinde et al., 2014). Our findings support existing research. It is only for

'perceived self-efficacy in using ICT at school' that gender, age and experience are significant in both countries. The main finding of this study is that gender, age and experience do not significantly explain the variation in teachers' attitudes and choices in these two Nordic countries. We can see diversity at the within-school level, and difference in treatment is required to create equal opportunities for all teachers in their ICT use in teaching. Equal distribution of ICT resources therefore might not be the best way to tackle the inequalities or diversity for creating equity in outcomes. Although equality could be achieved by sameness in treatment and the concept of justice, by overlooking individual factors and abilities, promoting equity is rather difficult. Typically, one would also expect that a lack of necessary ICT resources could help explain the variation in teachers' use of ICT, teachers' self-efficacy and their emphasis on developing ICT capabilities. Insufficient ICT equipment and a lack of technical and pedagogical support are pointed out as major hindrances in the effective use of ICT in teaching and learning (European Commission, 2013, p. 156). In the recently conducted ICILS 2018, although both school level and teacher data showed large differences in the availability of and appropriateness of ICT resources across countries, the teachers who were frequent ICT users in class were found to be more positive about teacher collaboration (Fraillon et al., 2019).

Concerning the explained variance in collaborative practices (H3), teachers' views on the lack of ICT resources and teachers' positive views on using ICT in teaching and learning were significant contributors in both countries. Overall, the results support this hypothesis, which indicates a lack of equity when it comes to experiencing collaboration. This means that some teachers experienced working in a supportive environment, whereas others experienced the opposite. Our assumption is that this variation provides teachers with different options and possibilities in terms of discussing ICT teaching and searching for support from colleagues. In-house training and adoption of ICT-related practices within schools contribute to the development of teachers' own ICT competence and support the improvement of a student-oriented pedagogical approach (Drent & Meelissen, 2008; Egeberg et al., 2012; Fraillon et al., 2014; Wang et al., 2014). However, notably, the situation is dependent on how much ICT is being used in terms of time and access and how well it is implemented in terms of teacher collaboration within schools (Fullan, 2007; Lindqvist, 2015).

When studying the contributors to variation in students' ICT literacy (CIL) scores, teachers' perceptions of a lack of ICT resources were found to be directly related to ICT literacy in both countries. This finding resonates with the fact that sufficient ICT resources along with technical support are key elements for ICT implementation in classrooms (European Commission, 2013). Nevertheless, it is pertinent that overall ICT investments also encompass areas such as teacher training and pedagogical support and do not only focus on material resources from higher levels of government.

As stated in H4, we expected to identify teacher collaboration as a significant contributor to student CIL scores. However, this was not revealed in our results. One explanation for this could be drawn from the ICILS study sampling design, in which

15 teachers were selected at random from all teachers teaching the target grade at each school (Fraillon et al., 2014). A second factor leading to the low collaboration finding could be that the sampled teachers were from different disciplines; therefore, they were not prone to collaboration in their teaching of the subject, possibly ignoring the need to use ICT (Wikan & Molster, 2011). The obvious benefit for teachers lies in making the best use of innovations in a collaborative environment and in developing their shared understanding. Vrasidas (2015) also reported that more than two-thirds of participating teachers who were provided with opportunities to learn from each other and collaborate with experts felt more prepared to integrate ICT in their classrooms. This highlights the potential importance of collaboration among teachers in terms of informal learning opportunities – for example, observing how other teachers use ICT in teaching as part of technology integration and teachers' professional development (Fraillon et al., 2014, 2019).

Among the attitude indicators, teachers' positive views about ICT use in instruction were significant predictors of collaboration in ICT use both in Norway and Denmark. Teachers with negative views towards ICT use in instructional practices or lower ICT self-efficacy may find collaborating with other advanced ICT users among their peers rather challenging. Furthermore, the absence of clear guidelines and school policies regarding ICT and teachers' characteristics and attitudes could play an important role in how their collaboration manifests in instructional practices.

Overall, variation was found between students concerning their CIL scores; however, when scrutinising the available variables from the survey, we did not identify any teacher variables that could explain sufficient levels of variance in the CIL scores. Our study cannot exclude the existence of the digital divide at the school or system level, but the most clear and comprehensive digital inequality was identified at the individual level. It seems, therefore, that the variance identified can be explained by the variance between students and not between schools. Krumsvik (2011) emphasised the importance of teachers using technology in instruction so that their students can achieve the digital competence aims set in the curriculum. The challenge is finding solutions that facilitate the equity of both access and use of ICT within schools by addressing the observed discrepancies in teachers' use of ICT in instruction.

6.4.1 Digital Inclusion/Equity

From a government perspective, ICT resources are intentionally distributed equally among schools, representing a step towards accomplishing digital equity. However, one could assume that factors of individual teacher, such as teacher competencies, teacher perceptions and their attitudes, might contribute to an extent towards inequality within schools. Haydn (2014) found that some teachers appear to be experts, whereas others have less expertise. In addition, as a guiding thought, providing teachers with support and appropriate pedagogical development is as important as ensuring ICT provision and support (European Commission, 2013, p. 156)

and should be prioritised. The ICILS 2018 reported that, across participating countries, teachers show higher usage levels of digital tools with general utility in classrooms than advanced digital learning tools (Fraillon et al., 2019). Without formal training courses in new digital technologies, much depends on the ability, compounded by the willingness, of the teachers to integrate ICT into instruction. At the individual level, teachers' personal and technology-related characteristics (e.g. prior experience with ICT and attitudes) play an important role in strengthening teachers' professional development involving ICT use in instruction (Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017). At the institutional level, aspects such as school policies concerning resource allocation, technology initiatives and revised strategies to support quality instruction and learning using ICT play a vital role in digital inclusion. For instance, the implementation of this institutional endeavour is reflected in Denmark, where a very high percentage of teachers report participating in professional development courses (ICILS 2018). In the case of scholarships for Norwegian teachers who pursue further education, the subjects mathematics, English, Norwegian, Sami and Norwegian sign language are given priority (The Norwegian Directorate for Education and Training, 2020). Among the 5775 teachers in 2020/2021, who are offered a scholarship or extra funding so that they use substitute teacher, only 419 teachers are given funds to study programming or professional digital competence.

Teachers' perceptions of the benefits of using ICT might be different from their actual perceptions of ICT use in instruction with respect to the problems and obstacles in the use of ICT in instruction (Carstens & Pelgrum, 2009). Therefore, it is essential for teachers to develop an updated teaching practice including optimal pedagogical use of ICT that supports not only students' learning processes but also their expertise in ICT literacy. Digital inclusion in schools would further be enhanced by constant efforts in meeting the ever-changing targets (e.g. resources) and by means of helping teachers become at ease and experienced in using ICT as part of their teaching.

Our analyses show that in most of the phenomena measured in the teacher survey in ICILS (related to both teachers' experience of using ICT, their views on ICT in teaching and learning, and their use of ICT in their teaching), there is little variation across schools in both Norway and Denmark. The small variation between schools is a challenge for the statistical analyses. However, from the equity perspective, less variation between schools supports the claim of high degrees of equality between schools. We consider this as an indicator of digital equality at the institutional level in both Norway and Denmark. Regarding students' CIL achievement, the main source of variance is not found at the school level but at the individual level, meaning that in these countries, observed equity is promoted more at the institutional level than at the individual level.

6.4.2 *Limitations and Future Directions*

Owing to the sampling design, the study did not provide a direct opportunity to connect either the students or teachers to a particular class (e.g. in Trends in International Mathematics and Science Study (TIMSS), an entire class is sampled, and one teacher per subject answers the teacher questionnaire; Martin, Mullis, Foy, & Hooper, 2016). This poses a clear limitation to our study and to understanding the relationship between teacher characteristics and students' ICT literacy. We attempted to aggregate the student scores at the school level and to distribute them to all teachers alike. Because ICT is integrated into all subjects and not treated as a specific subject, another limitation could be the ICILS test being too general and not directly related to student achievement in particular subject domains, although administering the self-report questionnaire to a large group of teachers gave us better knowledge of the teacher population. With the intention that teacher information should not be linked to individual students, a random sample of 15 teachers in schools with 21 or more teachers teaching the target grade regardless of the subject they taught was included in the ICILS (Fraillon et al., 2014, p. 34). This increased the complexity of situation because whether these teachers taught the students the years before remains unclear. We primarily relied upon the teachers' self-reports in our analyses and also did not test for measurement invariance to prove the equivalence of teacher views/beliefs between the two countries.

The data used in this study originate from 2013, and there is a need for further research on the topic. The second round of ICILS was conducted in 2018, but only data for Denmark is available because Norway did not participate in the ICILS 2018 cycle. In looking at the trend data for Denmark, the use of ICT in teaching has increased from 2013 to 2018. For instance, in 2018, 72% of the teachers reported using ICT on a daily basis, whereas this number was 40% in 2013 (Bundsgaard et al., 2019). The Danish teachers also reported significant changes in the degree to which they emphasised teaching in CIL-relevant topics, and they were even more self-confident in using ICT in 2018 than in 2013. The forthcoming ICILS 2023 will provide opportunities to further examine what characterises digital diversity in Norwegian and Danish schools. In addition, the study will provide an opportunity to examine the developments from 2013 to 2023 in both countries.

6.5 Conclusion

This study aimed to examine teachers' access to ICT, use of ICT in instruction, perceptions of lack of resources, attitudes towards ICT and collaborative practices. Teachers' perceptions of a lack of ICT resources in schools hinder the effective implementation of ICT in Denmark and Norway. However, equipping schools with ICT resources alone without a more holistic approach is unlikely to be productive in the development of ICT skills and knowledge.

Although some variation between schools was visible in ICT-related teacher measures, the school systems and administrators play a significant role in transforming practices and policies designed for encouraging the use of ICT in instructional practices. According to Cox et al. (2003), teachers are critical concerning the use of ICT because it defines not only the type of resources incorporated but also how those resources are used within classroom activities and during class time. In addition, when appropriate technological resources for each discipline are used, positive effects on learning can be anticipated because the availability of ICT equipment allows for its more frequent use by teachers. Teachers need to work in supportive environments where, aside from warranting access to new technologies, ICT implementation is seen as integral and relevant to achieving educational goals.

Our results suggest that, first, education systems need to focus on direct resourcing (ICT) to schools with larger needs for ICT resources. Second, setting concrete targets for achieving more equity by promoting and facilitating the extensive and consistent use of ICT by teachers, particularly in their instructional practices, should be considered a priority. Finally, the importance of teachers' (and schools') roles in promoting equity should be highlighted by setting concrete targets for equipping teachers with better ICT skills and enhancing their competence in transferring these skills to both students and colleagues.

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Appendix

The section 'ICT and teaching in your school' in the ICILS 2013 teacher questionnaire had the following items.

Teachers' Use of Specific ICT Applications (T_USEAPP)

Q. How often did you use the following tools in your teaching of the reference class this school year?

('Never', 'In some lessons', 'In most lessons' and 'In every or almost every lesson')

1. Tutorial software or [practice programs]
2. Digital learning games
3. Word processors or presentation software (e.g. [Microsoft Word®] and [Microsoft PowerPoint®])
4. Spreadsheets (e.g. [Microsoft Excel®])
5. Multimedia production tools (e.g. media capture and editing and web production)

6. Concept-mapping software (e.g. [Inspiration®] and [Webspiration®])
7. Data logging and monitoring tools
8. Simulations and modelling software
9. Social media (e.g. Facebook and Twitter)
10. Communication software (e.g. email and blogs)
11. Computer-based information resources (e.g. websites, wikis and encyclopaedias)
12. Interactive digital learning resources (e.g. learning objects)
13. Graphing or drawing software
14. E-portfolios

Teachers' Use of ICT for Learning (T_USELRN)

Q. How often does your reference class use ICT in the following activities?
('Never', 'Sometimes' and 'Often')

1. Working on extended projects (i.e. over several weeks)
2. Working on short assignments (i.e. within one week)
3. Explaining and discussing ideas with other students
4. Submitting completed work for assessment
5. Working individually on learning materials at their own pace
6. Undertaking open-ended investigations or field work
7. Reflecting on their learning experiences (e.g. using a learning log)
8. Communicating with students in other schools on projects
9. Seeking information from experts outside the school
10. Planning a sequence of learning activities for themselves
11. Processing and analysing data
12. Searching for information on a topic using outside resources
13. Evaluating information resulting from a search

Teachers' Use of ICT in Teaching Practices (T_USETCH)

Q. How often do you use ICT in the following practices when teaching your reference class?
('Never', 'Sometimes' and 'Often')

1. Presenting information through direct class instruction
2. Providing remedial or enrichment support to individual students or small groups of students
3. Enabling student-led whole-class discussions and presentations
4. Assessing students' learning through tests
5. Providing feedback to students

6. Reinforcing learning of skills through repetition of examples
7. Supporting collaboration among students
8. Mediating communication between students and experts or external mentors
9. Enabling students to collaborate with other students (within or outside school)
10. Collaborating with parents or guardians in supporting students' learning
11. Supporting inquiry learning

Teachers' ICT Self-Efficacy (T_EFF)

Q. How well can you do these tasks on a computer by yourself?
('I know how to do this', 'I could work out how to do this' and 'I do not think I could do this')

1. Producing a letter using a word processing program
2. Emailing a file as an attachment
3. Storing your digital photos on a computer
4. Filing digital documents in folders and subfolders
5. Monitoring students' progress
6. Using a spreadsheet program (e.g. [Lotus 1 2 3®, Microsoft Excel®]) for keeping records or analysing data
7. Contributing to a discussion forum/user group on the Internet (e.g. a wiki or blog)
8. Producing presentations (e.g. [PowerPoint® or a similar program]) with simple animation functions
9. Using the Internet for online purchases and payments
10. Preparing lessons that involve the use of ICT by students
11. Finding useful teaching resources on the Internet
12. Assessing student learning
13. Collaborating with others using shared resources such as [Google Docs®]
14. Installing software

Teachers' Emphasis on Teaching ICT Skills (T_EMPH)

Q. In your teaching of the reference class in this school year, how much emphasis have you given to developing the following ICT-based capabilities in your students?
('Strong emphasis', 'Some emphasis', 'Little emphasis' and 'No emphasis')

1. Accessing information efficiently
2. Evaluating the relevance of digital information
3. Displaying information for a given audience/purpose
4. Evaluating the credibility of digital information
5. Validating the accuracy of digital information

6. Sharing digital information with others
7. Using computer software to construct digital work products (e.g. presentations, documents, images and diagrams)
8. Evaluating students' approach to information searches
9. Providing digital feedback on the work of others (such as classmates)
10. Exploring a range of digital resources when searching for information
11. Providing references for digital information sources
12. Understanding the consequences of making information publically available online

Teachers' Positive Views on Using ICT in Teaching and Learning (T_VWPOS)

Q. To what extent do you agree or disagree with the following statements about using ICT in teaching and learning at school?
('Strongly agree', 'Agree', 'Disagree' and 'Strongly disagree')

1. Enables students to access better sources of information
2. Helps students to more effectively consolidate and process information
3. Helps students to learn to collaborate with other students
4. Enables students to more effectively communicate with others
5. Helps students to develop greater interest in learning
6. Helps students to work at a level appropriate to their learning needs
7. Helps students to develop skills in planning and self-regulation of their work
8. Improves the academic performance of students

Teachers' Negative Views on Using ICT in Teaching and Learning (T_VWNEG)

Q. To what extent do you agree or disagree with the following statements about using ICT in teaching and learning at school?
('Strongly agree', 'Agree', 'Disagree' and 'Strongly disagree')

1. Results in poorer writing skills among students
2. Only introduces organisational problems for schools
3. Impedes concept formation, which is better done with real objects than with computer images
4. Only encourages copying material from published Internet sources
5. Limits the amount of personal communication among students
6. Results in poorer calculation and estimation skills among students
7. Only distracts students from learning

Teachers' Lack of Computer Resources at School

(T_RESRC). Scale on six out of eight items.

Q. To what extent do you agree or disagree with the following statements about the use of ICT in teaching at your school?

('Strongly agree', 'Agree', 'Disagree' and 'Strongly disagree')

1. My school does not have sufficient ICT equipment (e.g. computers).
2. My school does not have access to digital learning resources.
3. My school has limited connectivity (e.g. slow or unstable speed) to the Internet.
4. The computer equipment in our school is out-of-date.
5. There is insufficient provision for me to develop expertise in ICT.
6. There is insufficient technical support to maintain ICT resources.

Teachers' Collaboration in Using ICT (T_COLICT)

Q. To what extent do you agree or disagree with the following practices and principles in relation to the use of ICT in teaching and learning?

('Strongly agree', 'Agree', 'Disagree' and 'Strongly disagree')

1. I work together with other teachers on improving the use of ICT in classroom teaching.
2. There is a common set of rules in the school about how ICT should be used in classrooms.
3. I systematically collaborate with colleagues to develop ICT-based lessons based on the curriculum.
4. I observe how other teachers use ICT in teaching.
5. There is a common set of expectations in the school about what students will learn about ICT.

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