CHANGES IN DIGITAL LEARNING DURING A PANDEMIC–FINDINGS FROM THE ICILS TEACHER PANEL

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Researching education, improving learning

The International Association for the Evaluation of Educational Achievement (IEA), with headquarters in Amsterdam, is an independent, international cooperative of national research institutions and governmental research agencies. It conducts large-scale comparative studies of educational achievement and other aspects of education, with the aim of gaining in-depth understanding of the effects of policies and practices within and across systems of education.

Foreword

It has been clear for over four decades that the need to evaluate a student's effective use of technology is paramount. That is why the International Association for the Evaluation of Educational Achievement (IEA) has been regularly conducting the International Computer and Information Literacy Study (ICILS), in order to assess these matters in the dynamic, ever-changing landscape of the modern world. Data are needed to understand how students' abilities to participate, investigate, create, and communicate through various digital platforms impact their social, work, and educational pursuits.

So too has the reach of the COVID-19 pandemic crossed into every aspect of life. More than just a health crisis, there have been adverse effects to humanitarian efforts, global and local economies, security, and education—to only name a few of the impacted sectors. All of us at IEA extend our deepest condolences for the losses facing individuals, families, and communities. And we want to send a resounding thank you to all members across health care systems who have put so much dedication into combatting this disease on the front lines. I wish the best to each of you in health, happiness, and safety. To move forward, our work must remain centered around solidarity and compassion.

In education, COVID-19 demanded a shift of additional digital use, and this created an urgency to understand how different learning environments are changing the learning experience for everyone involved. Thus, IEA created the ICILS Teacher Panel as a comparative study aimed at education systems that had previously participated in ICILS 2018. Mixtures of closures, remote learning, and other obstacles due to COVID-19 have greatly impacted education sectors worldwide. Because of these unexpected roadblocks in effective schooling, it has been the responsibility of IEA to show support to our members and educational systems around the world by conducting sound and reliable research for them to utilize. There is a need to understand in what ways the pandemic has impacted (and continues to impact) students, teachers, administrators, and other individuals. This study, therefore, acts as a foundation for policymakers, researchers, and other stakeholders to better grasp the situation and respond accordingly, with aid from a longitudinal perspective and trend data. The questions and work done in ICILS 2018 were the groundwork for a quick response to the crisis in 2020. Through such research, the study aims to answer: what has changed in education during COVID-19 times, and how can education continue despite these impediments?

Seeing how countries, principals, and teachers have innovated their interactions with students is admirable. They have had to adapt quickly to situations out of their control. The obstacles have been unpredictable and complicated, but many educators and learners have proven themselves to be resilient. Several have drawn on digital solutions in order to engage with their students in a remote capacity. However, this has been a significant shift for many teachers and students alike. There is also a question of whether individuals have proper access to the technology needed to connect to their new education systems, let alone the ability to use it efficiently in order to properly teach or learn from a digital platform.

Additionally, knowing that education institutions have been forced to adapt is not the same as having the data to see how they have done so and to what degree these changes have been effective. That is where the urgency for the supplementary ICILS Teacher Panel came into focus. This information must be reliable, and part of that means collecting data in a sensitive and mindful manner while the experiences incurred are still fresh in the memory of teachers, students, and administrators. In addition, as it was necessary to capture these experiences in a timely manner to ensure responses reflected changes caused by the pandemic, this resulted in one of the quickest study implementations in IEA's history.

With ICILS 2018 as a baseline, this means that instruments, procedures, and samples were readily available. Such conditions also supported the ICILS Teacher Panel to react in the much needed timely manner. This likewise allowed for the research to report trend data. Nonetheless, key to all studies is the willingness of countries to participate, and we thank Denmark, Finland, and Uruguay for their cooperation in the rapid response necessary for this study to be an effective aid for research, practices, and policies.

Though this study was conducted much quicker than usual, we kept quality and ethics at the forefront. That was made possible by the dedicated team members around the world. I am grateful for the hard work put in by all colleagues and partners. Rolf Strietholt, Julian Fraillon, and Sabine Meinck have done phenomenal work in guiding the ICILS Teacher Panel. The authors and contributors of each chapter have been fundamental to this process, so thank you for your pursuit of sound research and willingness to adapt to this last-minute addition. I would like to further thank the team at IEA Hamburg, as well as the entire staff at the national centers; your support, advice, and hard work were foundational in the success of this study. I am also appreciative of the Publications and Editorial Committee; with their expert guidance and review services, this ICILS Teacher Panel was able to maintain IEA's high standards of research excellence.

Finally, thank you to the teachers and principals that responded and participated despite the ever-increasing challenge of managing the disruption. It has hardly been easy facing the havoc that COVID-19 brings to this world, but your willingness to gain more insight on how to continue to promote the highest quality of education reflects your resilience and dedication.

Dirk Hastedt
EXECUTIVE DIRECTOR IEA

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Executive summary

Rolf Strietholt, Julian Fraillon & Sabine Meinck

About the study

The International Computer and Information Literacy Study (ICILS) Teacher Panel is an international comparative study that investigates change in the use of information and communication technology (ICT) before and during the COVID-19 pandemic in Denmark, Finland, and Uruguay. It aims to study issues related to three sets of research questions: (1) Have ICT-related issues such as computer resources, attitudes towards technology, and the use of communication and information technology changed after the outbreak of COVID-19? (2) Did social inequality in educational opportunity increase during the COVID-19 pandemic? (3) How stable is the use of ICT-related issues at the teacher level, and have international differences in the use of ICT increased or decreased over time?

The Teacher Panel builds on the existing random samples of schools and teachers from the 2018 ICILS survey. In late 2020/early 2021 the same samples of schools and teachers were surveyed again, with additional information collected from the principals and ICT coordinators at those schools. The ICILS Teacher Panel did not survey students because it was not feasible to trace the 2018 grade 8 students.

In the three countries, a total of 2165 teachers participated in both the 2018 and 2020 surveys. Furthermore, principal questionnaires were completed at 288 schools and ICT coordinator questionnaires were completed at 263 schools in both study years. The ICILS Teacher Panel study is the only international teaching panel dedicated to investigating changes in schools' use of ICT in the context of COVID-19. The same teacher, principal, and ICT coordinator questionnaires were administrated in 2018 and 2020 which allows us to study the use of ICT technology for learning in education, longitudinally. The questionnaires cover ICT-related issues such as IT-resources at school, attitudes towards technology, and the use of ICT for teaching and learning.

The ICILS Teacher Panel is based on the random samples taken from schools and teachers in Denmark, Finland, and Uruguay in 2018 to provide representative information about the three countries. However, it is important to note that the data are subject to a certain degree of uncertainty, as not all schools and teachers participated in the 2018 surveys. Furthermore, in 2020 not all schools and teachers from 2018 participated in the repeated survey. Chapter 6 summarizes information on the 2018 baseline sample and provides detailed information on the 2020 response to evaluate the uncertainty and generalizability of the results reported in this report.

Main findings

In this section, we summarize the ICILS Teacher Panel findings detailed in the following chapters, and we elaborate on general patterns found in the results. While previous cross-sectional findings from ICILS and other studies have revealed enormous variations within and between countries in the use of ICT for teaching and learning, the ICILS Teacher Panel provides a longitudinal perspective. We specifically examine changes in ICT use that have occurred since the outbreak of the COVID-19 pandemic. We explore not only general changes in use, but also the equality of access to ICT-supported learning and teaching within and across countries.

A substantial increase in the use of ICT for learning

A key finding of the ICILS Teacher Panel was that teachers in all countries have been using computers and information technology for learning and teaching significantly more frequently since the outbreak of COVID-19. In particular, learning management systems and collaborative software were used much more often to share learning material and to communicate with students. In addition to the increased frequency of ICT use, teachers reported that ICT-resources have improved at their schools, they collaborated more

with their colleagues, and they gave more emphasis on students being able to use ICT for learning. In summary, the ICILS Teacher Panel provides strong evidence that teachers in Denmark, Finland, and Uruguay purposefully used ICT to continue learning during the pandemic.

In contrast to the increased use of ICT for learning and teaching, there has been little change in teachers' general attitudes about the advantages and disadvantages of ICT for learning and teaching. These different patterns of change may suggest that teachers used ICT more often because COVID 19-related constraints limited the continuation of normal onsite teaching, rather than because their beliefs about ICT have changed. This is further evidenced by the lack of change in teachers' responses relating to learning goals.

The biggest changes are found in areas where ICT was rarely used before

From a comparative perspective, we observed that ICT was used most frequently in Denmark, followed by Finland and then Uruguay. Although the international differences observed in 2018 did not completely vanish in most areas, we observed a reduction. The reduction in international differences was primarily a result of the reported large increase in ICT use in Uruguay, which had the lowest recorded ICT use out of the three countries in the 2018 baseline data. The changes were less pronounced in Finland, which was starting from a higher baseline for ICT use in the 2018 data, and we found moderate change in Denmark, where ICT was already deeply integrated in schools in 2018.

Teachers' experience matters

The ICILS Teacher Panel shows, unsurprisingly, that teachers who already used ICT before the pandemic continued to do so during the pandemic. This was an almost universal pattern that we observed across most topics. During school closures, teachers who have used ICT before were at an advantage by being able to draw on their previous experience. On the other hand, this evidence suggests that teachers, who have not used ICT before the COVID-19 pandemic, do not manage to catch-up with their more experienced colleagues. Consequently, in times of crisis, it helps if teachers are already familiar with using ICT. Strong correlations between the use of ICT by teachers in 2018 and again in 2020 were observed within all countries.

Inequality of educational opportunity remained stable

To investigate inequalities in educational opportunity, we used the ICILS Teacher Panel data to compare ICT resources and teachers' use of ICT in socioeconomically advantaged schools with schools that have socioeconomically disadvantaged student bodies. In 2018, we found rather small differences. During the pandemic, we saw that the existing opportunity gaps either remained the same or decreased. The narrowing of the gaps typically reflects the fact that the changes were larger at the socioeconomically disadvantaged schools than at the advantaged schools.

It was widely suspected that performance gaps between social groups widen during COVID-19. The ICILS Teacher Panel cannot provide evidence on this hypothesis, as we did not collect data on achievement or inequality in students' access to ICT-related learning resources at home. However, access to and use of ICT for learning has hardly changed in the school context. Our study suggests that efforts were made to close the ICT-related opportunity gaps in the three participating countries. Although this is a positive result, it seems important to us to emphasize that ICT plays such a crucial role in times of distance learning and therefore the remaining gaps should also be addressed.

Part I

Context and Findings

CHAPTER 1

Introduction

Rolf Strietholt, Julian Fraillon & Sabine Meinck

The International Computer and Information Literacy Study (ICILS) Teacher Panel is an international comparative survey conducted in Denmark, Finland, and Uruguay in 2018 and 2020. Building on existing data from ICILS 2018, teachers were surveyed again during the COVID-19 pandemic to measure changes in ICT equipment and use and additional information was collected from school principals and ICT coordinators. In this chapter, we discuss the background and origins of the study, as well as the key questions we hope to answer with the ICILS Teacher Panel.

1.1 Information and communication technology during school closure

The importance of information and communication technology (ICT) for teaching and learning has been increasingly recognized in the past decades. However, at a time of school closure as witnessed on an extensive scale throughout the world, during the COVID-19 pandemic, the need for evidence on the use of computers and technology for learning, and the determinants of ICT use is greater than ever. During the COVID-19 pandemic, many students worldwide did not physically enter schools for a temporary period, and in this context, expectations are high that the use of computers and technology can effectively support student learning. However, the importance of digital learning also goes beyond the current pandemic, extreme weather conditions, strikes, and other events that have, in the past, and will continue, prevent children from visiting school buildings and classrooms. Consequently, there is a great need for evidence on the effective use of ICT in education to guide schools and education systems on how best to support digital distance learning.

Since the 1990s, the IEA has been conducting international studies on the effective use of ICT in education. The earlier studies addressed general expectations of digitization and its consequences for schools and conducted case studies at project schools. In more recent years, IEA ICILS studies have also covered student assessments (Fraillon et al., 2020a, 2020b; Fraillon et al., 2014; Pelgrum & Anderson, 2001; Pelgrum & Plomp, 1993; Plomp et al., 2009). The largest ongoing IEA study in this area is the ICILS (Fraillon et al., 2020b), which surveys the use of ICT in secondary schools and assesses students' computer and information literacy and computational thinking skills. ICILS has been administrated in 2013 and 2018 and both these studies have revealed considerable variation in the use of computers and technology for learning, not only between, but also within countries. Some schools and teachers use computers and technology more frequently and differently than others. Although these findings have been replicated repeatedly, at present, the reasons for large differences in the use of computers and technology are not well understood. A limitation of previous international comparative research relates to the cross-sectional design of studies like ICILS, PISA, or TIMSS, which lack the ability to provide cause and effect evidence that may be investigated with a longitudinal design (Gustafsson, 2008; Johansson, 2016; Rutkowski & Delandshere, 2016; Strietholt et al., 2014). It is very difficult to draw inferences on the determinants of the use of computers and technology for learning with cross-sectional data. While the focus of this report is to describe the changes between 2018 and 2020 at the country level, the longitudinal data provide multiple opportunities for further secondary analysis of the panel data at the teacher level. IEA's ICILS Teacher Panel is the first IEA panel study to be administered since the Second International Mathematics Study, administrated from 1981 to 1983 (Robitaille & Garden, 1989; Westbury & Travers, 1990).

1.2 ICILS 2018 as a baseline for an international teacher panel

The panel study was initiated relatively spontaneously when it became clear that COVID-19 was having a dramatic impact on school-based learning. Schools around the world were closing and the need for distance learning was increasing significantly. The pandemic-initiated school closures, greatly heightened

the need to use computers and technology for learning. While the role of computers and technology in school learning has grown gradually in recent years, they would not have such a critical role in school learning today, without COVID-19. From a methodological perspective, the outbreak of COVID-19 is an unprecedented incident to the research of the determinants of computer and information technology use, because the school closures were an external shock to education systems creating increased demand and considerable pressures for schools to use computers and technology for learning. Such longitudinal variation can be studies to understand the factors that predict computer use.

Although the need for a panel study on changes in ICT resources and their use was evident, it was impossible to plan a study in advance because no one anticipated COVID-19 and the subsequent school closures. Our approach to circumvent this problem was to use existing data as a baseline measurement. From a comparative perspective, IEA's ICILS provides a unique database and infrastructure to construct international panel data on ICT in schools (for further information on ICILS see the textbox below as well as the assessment framework, the international report, and the technical reports: Fraillon et al., 2019; Fraillon et al., 2020a, 2020b; Fraillon et al., 2014). The last wave of the ICILS survey was conducted in 2018, and in order to use results from this survey as a baseline measurement it was necessary to identify teachers and schools that had participated in this study for the ICILS Teacher Panel survey. Furthermore, the ICILS questionnaires map key content areas, including the provision of ICT resources, their qualitative and quantitative use by teachers for learning and teaching, and teachers' attitudes towards technology. It normally takes a long time to develop questionnaires for international studies, for the Teacher Panel, however, the questionnaires had already been piloted and were available in different languages. Another advantage to using the ICILS infrastructure was the availability of an established online survey tool for administering the questionnaires. The use of the existing research infrastructure made it possible to develop a lean and inexpensive study design that could be implemented within a short period of time.

IEA ICILS factsheet

- ***Study name:*** International Computer and Information Literacy Study
- ***Years of data collection:*** 2013 and 2018 (the next study cycle is planned for 2023)
- ***Target population:*** Grade 8 students
- ***Instruments:*** Student assessment in computer and information literacy (CIL) and computational thinking (CT, optional since 2018); context questionnaires for students, teachers, principals, ICT coordinators, and national research coordinators
- ***Samples:*** In 2013, over 60,000 students and 36,000 teachers from more than 3,000 schools in a total of 21 educational systems (18 countries and three benchmark entities). In 2018, over 46,000 students and 20,000 teachers from more than 2,200 schools in a total of 14 educational systems (12 countries and two benchmark entities)

1.3 Study aims and the present report

We hypothesize that there are still large variations across countries, schools, and teachers in how computer- and technology-based learning has changed during the COVID-19 pandemic. Against this background, the ICILS Teacher Panel has two main aims. First, we aim to study the transition to more technology-based learning. More specifically, we will address issues related to three sets of research questions:

1 Have ICT-related issues such as computer resources, attitudes towards technology, and the use of communication and information technology changed after the outbreak of COVID-19? The ICILS Teacher Panel uses longitudinal data from 2018 and 2020 to investigate this question in Denmark, Finland, and Uruguay.

2 Did inequality in educational opportunity increase during the COVID-19 pandemic? Specifically, we are interested in changes in the opportunity gaps between teachers at schools with socioeconomically advantaged and disadvantaged student bodies. We aim to compare the opportunity gaps in 2018 with 2020.

3 How stable are ICT-related issues such as computer resources, attitudes towards technology, and

the use of communication and information technology within and across countries over time? We use panel data to study temporal stability in, for example, ICT use. At the country level, we are interested in whether differences increase or decrease over time.

The present report aims to provide empirical evidence on these three sets of questions. However, a second aim of the ICILS Teacher Panel is to provide data to identify factors that explain why some teachers and schools have been more successful in using computers and technology for learning than others. We collect data to cover both quantitative aspects, such as the frequency of computer use, and qualitative aspects, such as the use of specific technologies (learning platforms, video conferencing, etc.). We consider a large and diverse set of explanatory variables including the IT infrastructure available at schools, school leadership and teachers' attitudes, experience, and training with ICT technology. It is beyond the scope of this first report to study the determinants of computer use, but the data of the ICILS Teacher Panel will be released for secondary analyses to the research community.

1.4 Structure of the report

The next chapter provides a baseline description and context for the present study. Together with researchers from the respective countries, we describe and compare the political responses to the educational disruption in Denmark, Finland, and Uruguay. Among other things, we summarize how long schools were closed and what political measures were implemented regarding ICT use in education. The following chapters present the findings on the general changes between 2018 and 2020 in terms of the levels of ICT use, as well as social inequality in educational opportunity. In the remaining chapter, we describe the samples, data collection, instruments, and methods.

CHAPTER 2

National contexts for schooling during COVID-19

Rolf Strietholt, Jacob Christensen, Cecila Hughes & Kaisa Leino

To understand how schooling changed during the COVID-19 pandemic, it is necessary to know the respective national contexts. While international comparisons are appealing, assessing differences are inherently difficult, the COVID-19 pandemic provides an additional challenge because we have little literature and previous research to draw upon. For this reason, we invited educational experts from the respective national contexts to co-author this chapter. In part, this chapter draws on figures from Johns Hopkins University on the spread of COVID-19 (see Figure 2.1), which we use to trace chronologically how the school systems in Denmark, Finland, and Uruguay have dealt with the pandemic since the outbreak in early 2020 to March 2021. A key issue for this study is when, how, and for how long schools were closed. Another aspect of the research in this chapter, focuses on whether the educational changes that occurred, were accompanied by central governmental guidance or targeted investment programs for improving ICT infrastructure and professional development.

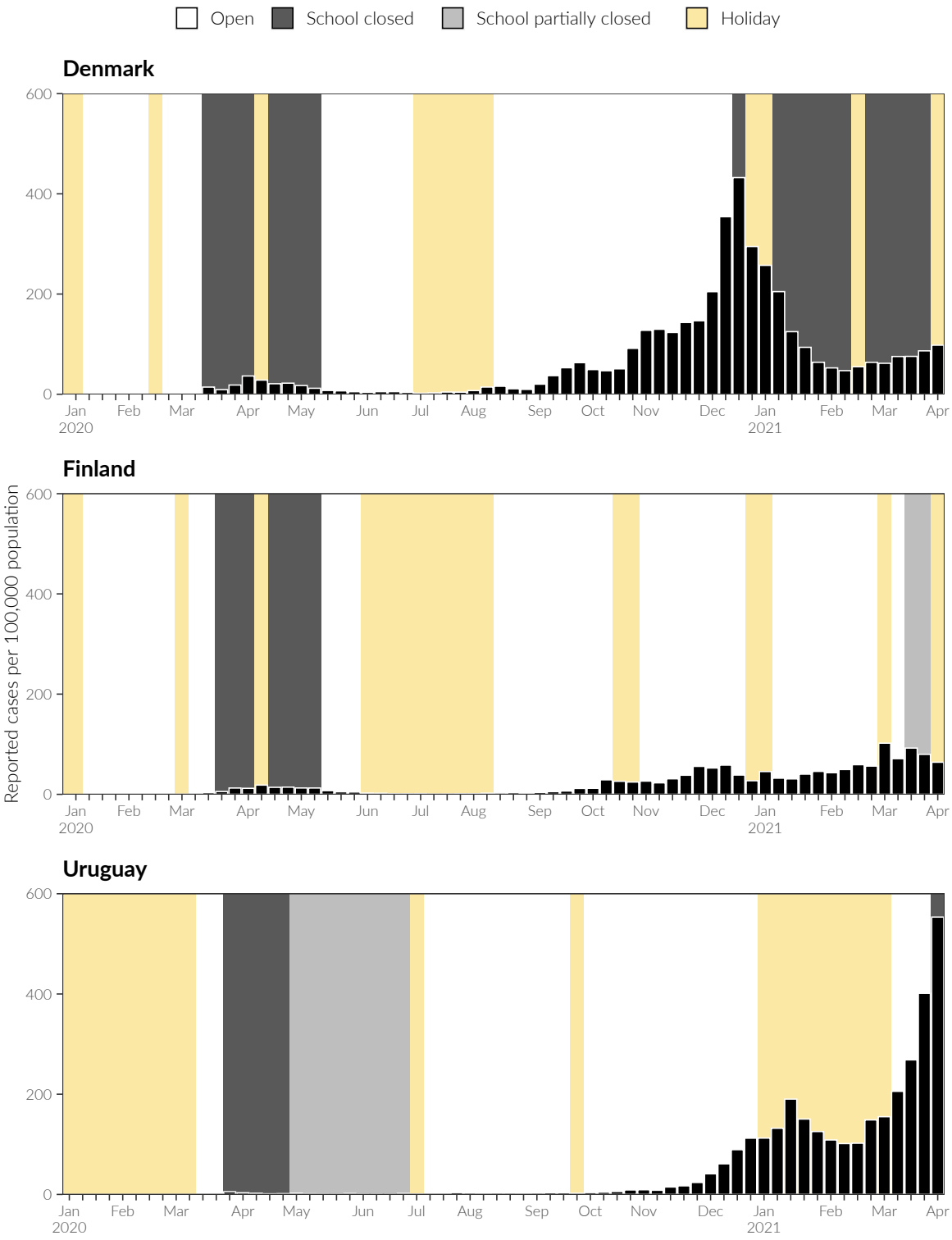
2.1 The spread of COVID-19

The increased importance of ICT for school learning and teaching is framed by COVID-19-related school closures. For this reason, we first look at the prevalence of COVID-19 in Denmark, Finland, and Uruguay between the beginning of 2020 until the end of the ICILS Teacher Panel survey period in March 2021. According to the World Health Organization (2021), in Denmark, the first wave of infection in 2020 began in week 8 and peaked in week 14 with 2,113 infections. During this first wave, approximately 600 deaths were associated with COVID-19. Finland experienced its first wave at a similar time, which peaked in week 15 with 1,023 registered infections that week. In Finland, slightly over 300 COVID-19 related deaths were registered during the first wave. The populations of Denmark and Finland are similar in size, measuring at 5.8 and 5.5 million respectively, meaning Denmark was hit about twice as hard as Finland.

Uruguay has a population of about 3.5 million. Compared to the two Nordic countries, the first infections were not reported in Uruguay until week 11 in 2020 (World Health Organization, 2021). Thereafter, there was no exponential outbreak, but rather the incidence of infection was under control for a long time and remained at a relatively low level of about 100 infections per week. During this time, the number of COVID-19 reported deaths remained low at a maximum of 5 per week. The first real wave of infections with exponential growth started in week 45 of 2020 and reached an intermediate peak in week 1 of 2021, with more than 6,607 infections registered at its peak. After a temporary levelling off, a second peak occurred in week 14 with more than 25,000 infections registered. Between late 2020 to late March 2021, nearly 1,000 Uruguayans died due to COVID-19.

The second wave started in Denmark in week 35 and peaked in week 51 with about 25,000 infections registered that week. During the second wave, nearly 1,800 deaths due to COVID-19 were recorded in Denmark. In Finland, the second wave remained much flatter than in Denmark, with an interim peak of about 3,000 new infections recorded in week 50, and fewer than 500 deaths were recorded due to COVID-19 by the end of March 2021. Figure 2.1 shows the weekly infections for each of the three countries.

Figure 2.1: School closures and the weekly reported COVID-19 cases per 100,000 population



The month label represents the week in which the month begins (e.g., January 1, 2020 falls on Wednesday then the week starting December 30, 2020 is labeled as Jan 2020). In Finland, both winter (in February or March) and autumn (in October) holidays vary from region to region, but individual schools have only one week of holiday. The approximate weeks of holidays are marked.

2.2 Central guidance on school closures and distance learning

2.2.1 The first closure

In early 2020, the governments in Denmark, Finland, and Uruguay required all schools and other public institutions to close their premises within two to three weeks after the first COVID-19 infections were registered in each country. However, the duration of the school closures and how schools reopened were organized differently across countries and over time. Although it is difficult to determine whether these differences are a cause or a result of the different pandemic trajectories, it seems useful to note, and thus they are briefly described below.

While school closures were decided centrally by the respective governments, it was largely up to local schools and teachers to plan and organize learning during school closures. Instead of teaching in school premises and classrooms, teachers were asked to make use of the various types of distance learning options available, such as videotelephony, digital learning environments, paper-based weekly learning packages, and self-learning. Anecdotal evidence from newspaper reports and conversations with teachers and the parents suggest that there were large variations in the extent to which options were used and how teachers organized distance learning in all three countries.

During the first closure period, there were only a very few exceptions allowed for children to enter school in all three countries. The exceptions were mostly limited to parents working in the medical sector and other areas of public infrastructure who were not able to arrange childcare at home. Care services were provided especially in preschool and primary education, as it was argued that there is a greater need for care in these age groups than for older children. The right to education had only a subordinate role, although exceptions were possible for children in vulnerable situations or with special educational needs in all three countries. In Uruguay, even during the lockdowns, lunches were served at schools for children from low socioeconomic backgrounds. Also, in Finland, parents had the option to request the schools provide a lunch for their children. It was then up to the municipalities to prepare lunch either daily or for several days, and sometimes food was provided that had to be prepared at home by the parents or children themselves.

2.2.2 The reopening phase

In Denmark and Finland, schools remained closed for two months in the first half of 2020, and were reopened for two weeks in Finland, and four weeks in Denmark, just before the summer vacations. After the summer break, schools in Denmark and Finland remained open for the most part, although there were repeated localized school closures depending on the incidence of infection and local outbreaks. In Finland, the government defined three phases of the epidemic: baseline phase, acceleration phase and community transmission phase. With these guidelines, local officials determined which phase their region was presently experiencing and measures were taken or relaxed, accordingly. Additionally, some schools opted to continue using a hybrid format, where students alternated between in-person and distant learning every other week or fortnight.

In contrast to the two Nordic countries, schools in Uruguay closed for only about one month in the beginning of the pandemic. Thereafter, students gradually returned to school, factoring in, both social vulnerability and local hygiene standards. In a first step, schools in rural areas opened, as introducing higher hygiene standards were easier to achieve. One and a half months later, special education schools and schools in disadvantaged, rural areas returned to school. Two weeks later, all schools in rural areas reopened and another two weeks after that, all schools in metropolitan areas reopened. The difference between reopening times in rural and metropolitan areas was due to the assumption that it is easier to keep social distance in rural areas on the way to school and in school buildings. The reopening process also differed between public and private schools. Almost all private schools reopened daily classes for all students, but with fewer hours per day. In contrast, most public schools divided students into groups to attend face-to-face classes two or three times a week. In November, the social distance criterion was made more flexible, and more students were allowed in school and for longer hours.

The return to schools was accompanied by a series of national hygiene measures in all countries. The governments specified that there must be extra space between students, contact between students and

teachers should be reduced, and strict hygiene measures must be applied. It was up to the individual schools to adapt these guidelines to local conditions and then implement them. The key measures introduced were the use of larger rooms, desks placed further apart, obligatory masks in certain situations must be worn, lunch served in classrooms instead of in cafeterias, and activities with close contact were avoided (e.g., contact sports, festivities, etc.). No external visitors were allowed, meaning only students and school staff were permitted to enter school premises. In Uruguay, classes were divided to create more space and reduce the number of contacts. In Finland, special attention was given to schools to ensure that students from different classes had little contact. Consequently, some schools were separated into different areas and larger rooms were used wherever possible. In all countries, students were taught to wash their hands frequently and correctly with soap, sanitizer and disinfectants were provided, and coughing techniques were addressed. In addition, there was an increased awareness of symptoms of COVID-19 among teachers, parents and students and, in case of doubt, students were not allowed to enter schools.

2.2.3 The second closure

Denmark was hit by a massive second wave of COVID-19 infections in the fall of 2020. As a result, all schools were closed again for several weeks in mid-December. It was not until 8 February 2021 that elementary schools up to grade four were reopened, while higher grades remained completely closed until early April. As previously mentioned, the second wave of infections was much flatter in Finland than in Denmark and as a result, there were no further closures of schools on a national level, schools were only closed in specifically affected regions after an increase in infections in mid-March 2021. Furthermore, the threshold for quarantines for entire classes was low in Finland, which largely prevented the closures of entire schools. However, there were a few cases where entire schools were closed for two weeks when multiple infections occurred.

In Uruguay, the summer vacations began at the end of December 2020, at which time infections levelled off considerably. Then, at the end of the summer vacations in late February 2021, there was an exponential spread on a scale previously unseen in Uruguay. As a result, only three weeks after the summer vacations, all schools were closed again.

We would like to reiterate that we present the situation in the three countries to provide context for the ICILS Teacher Panel survey results, and we collected the data for the second measurement point in late 2020/early 2021. For this reason, our results are limited to the period until the end of March 2021, although it must be noted that schooling was still significantly affected by COVID-19 after that date.

2.3 School absence during the pandemic

School learning has been disrupted not only by school closures, but also by children failing to attend even when schools were reopened. The central guidance in Denmark and Finland was that parents were expected to send their children to school when they reopened. Officially, children were allowed to stay home only if they were in quarantine, had COVID-19, were particularly vulnerable or in close contact with others at risk in their home environment. Checks or certificates were not usually required. In Uruguay, until October 2020, it was at the discretion of parents whether to send their children to school. From October, attendance became compulsory again, but vulnerable children were allowed to stay at home.

2.4 Investments in ICT infrastructure and professional development during the pandemic

In Denmark, computers, internet access, and central learning platforms were already widespread and common before the pandemic. Hence, there has not been a perceived need for large investments in ICT infrastructure. However, teachers were offered several ICT-related professional development opportunities.

In Finland, according to the ***Basic Education Act*** (2010) the equipment, internet access, and learning materials required for teaching are free of charge for students in basic education. Schools are required to provide a computer or other sufficient digital devices to a student who does not have equipment at home. Even before the pandemic, however, in Finland, internet access as well as computers coverage at home was common. During COVID-19, schools sent a questionnaire to parents to survey which students had an internet connection and a suitable device. If a parent reported that these were not available, the school

provided them to the student. However, most students were able to use the existing equipment at their home.

In Uruguay, all schools, parents, and teachers received access to a digital learning platform to mitigate the educational disruption (***Ceibal en Casa***). The comprehensive platform combined different services for teachers and students including a learning environment (e.g., learning management system, social networking functionalities, etc.), math platform (e.g., adaptive and gamification learning systems), access to a national digital library (e.g., 7,000 books and multimedia resources), and training and support (e.g., tutorials, consultation services, exchange forums, virtual training and guidelines for remote teaching, etc.). The learning platform also offered services for parents, including advice on how to support pedagogical continuity from home, social networking opportunities, and a section on socio-emotional support to manage stress caused by the crisis. Furthermore, the infrastructure was expanded, and the transmission volume was increased by 400% in order to enable all children to use the learning platform.

CHAPTER 3

Changes in the use of ICT

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3.1 Introduction

The instruments used in the ICILS Teacher Panel are based on the ICILS 2018 teacher, school principal and ICT coordinator questionnaires. These questionnaires inquire into the factors that may influence students' computer and information literacy (CIL) and computational thinking (CT) (Fraillon et al., 2019). A central objective of ICILS 2018 was to capture the context in which the measured student achievement outcomes, in CIL and CT, are developed. In ICILS, these factors have been conceptualised and classified as i) antecedents,[1] and ii) as process-related[2]. Both groups of factors can manifest at different levels: the wider community, schools and classrooms, home and peer contexts, and at the individual student level. The data from the teacher, school principal, and ICT coordinator questionnaires presented in this and the following chapters represent antecedent and process-related factors at school and classroom levels.

The teacher questionnaire includes topics related to teachers' use of computers and other digital devices and teachers' attitudes toward the use of these technologies. The questionnaire asks teachers about different considerations related to ICT, for example, teachers' familiarity with ICT, the use of ICT in teaching, their perceptions of ICT, and professional development opportunities on the use of ICT in teaching, and also some background questions. Some research suggests there is a relationship between the experiences of using ICT when teaching staff, the extent of teachers' ICT use, and teachers' attitudes toward digital technologies as tools for teaching and learning (Drossel et al., 2017; Fraillon et al., 2014). Positive teacher attitudes towards the use of ICT for teaching and learning are regarded as important factors for the implementation of digital technologies for teaching and learning at schools (Lawrence & Tar, 2018; Tondeur et al., 2017).

Moreover, previous data from ICILS 2013 revealed that across participating countries there was a recognition by teachers of the advantages of using ICT in teaching (Fraillon et al., 2014). In particular, empirical evidence suggests that to enable teachers' use of ICT and the teaching and learning of ICT-related skills, it is important to develop teachers' expertise in ICT (Lawrence & Tar, 2018; Scherer & Siddiq, 2015). Furthermore, there is evidence that teachers' self-efficacy regarding the use of ICT influences how they use it in the classroom (Fraillon et al., 2014; Hatlevik & Hatlevik, 2018). The ICILS 2013 results also showed that teachers' positive and negative attitudes toward the use of ICT are associated with the extent to which they use it in teaching (Fraillon et al., 2014). Research also suggests that the encouragement to use ICT for teaching can be stimulated by teacher collaboration (Caspersen & Raaen, 2014; Drossel et al., 2017; Fraillon et al., 2014).

Research has suggested that school-level factors related to ICT resourcing and priorities influence both the way in which teachers use ICT for teaching, and students' ICT-related learning (Fraillon et al., 2014; Lawrence & Tar, 2018). To this end, ICT coordinators participating in ICILS are asked about ICT resources, ICT use, ICT technical support, and provisions for teacher professional development on ICT in their schools. Similarly, school principals participating in ICILS are asked to provide information about school characteristics and policies, procedures, and priorities for ICT. All of these topics are considered important in providing context and information about the status of ICT-related constructs in the participating countries, in the years that ICILS is conducted.

1 Antecedents are exogenous factors that condition the ways in which CIL/CT learning takes place. They represent contextual factors that are not directly influenced by learning-process variables or outcomes. These are for example school ICT resources, stated ICT curriculum, or school/classroom characteristics (Fraillon et al., 2019).

2 Process-related characteristics are understood to directly influence CIL/CT learning and are constrained by antecedent factors and factors found at higher levels. These factors could include variables such as opportunities for CIL/CT learning during class, teacher attitudes toward using ICT for study tasks, and students' use of computers at home (Fraillon et al., 2019).

In this chapter, we report on the first findings from the teacher, principal, and ICT coordinator surveys on ICT-related issues such as resources at schools, attitudes toward digital learning, and the use of computers for teaching and learning, from the surveys carried out in 2018 and 2020. We use panel data from Denmark, Finland, and Uruguay to investigate the changes that occurred during the COVID-19 pandemic. The main research question is whether resources, behavior, attitudes and other ICT-related issues changed after the outbreak of COVID-19.

In the subsections, the results for items are grouped by topics. To ease the interpretation, the item responses are dichotomized, and we report on the percentages of a selected category in the years 2018 and 2020, as well as the change in percentage points between 2018 and 2020. We point out statements where a statistically significant difference in percentage points was observed between the years 2018 and 2020. Point estimates and their standard errors are derived as outlined in chapter 7. Moreover, we present the tetrachoric correlation[3] between data collected in the two years to analyze stability in the responses over time. Positive inter-individual associations suggest that the measures in 2018 predicted the same measure in 2020.

3.2 Teacher survey

In this section, we use data collected from the teacher questionnaires in 2018 and 2020, and report the results related to teaching with and about ICT in schools and across the participating countries. We focus on teachers' familiarity with ICT, their views regarding its use for teaching and learning, and teachers' perceptions of schools' ICT learning environments. Furthermore, we review the emphasis teachers place on developing students' CIL and CT and their actual use of ICT in lessons and lesson preparation.

3.2.1 Teachers' familiarity with and views of ICT

Teachers' experience with ICT use

The extent of teachers' use of ICT is related to their experience with and attitudes towards ICT. The ICILS teacher questionnaire asked teachers about their approximate years of experience using ICT in their teaching, during lessons, as well as when in lesson preparations. The response options are "never," "less than two years," "between two and five years," or "more than five years". The majority of teachers across the three countries reported having used ICT for more than five years. However, when considering deficits in the use of ICT in teaching, it is of interest to consider the teachers who have never used ICT. Results are presented as percentages of teachers who reported that they never used ICT ***during lessons*** and when ***preparing lessons***.

The results for both statements are presented in Table 3.1. In Denmark and Finland in 2020, no teachers reported that they have never used ICT ***during lessons*** or when ***preparing lessons***. However, in Uruguay there remained a very small percentage of teachers who reported that they have never used ICT ***during lessons*** (3%) and when ***preparing lessons*** (1%). These proportions have decreased significantly since 2018, from 9% and 5%.

Teachers' use of ICT

Teachers were asked to rate their frequency of ICT use ***at school when teaching***, ***at school for other work-related purposes***, ***outside school for work-related purposes***, and ***outside school for non-work-related purposes***. The available response options were "never," "less than once a month," "at least once a month but not weekly," "at least once a week but not every day," or "every day". Table 3.2 presents the percentages of teachers who reported using ICT every day for these purposes.

No statistically significant changes were observed for the use of ICT ***outside school for non-work related purposes*** between 2018 and 2020. We observed a statistically significant increase in daily use of ICT ***at school when teaching*** and a similar increase in the use of ICT ***outside school for work-related purposes*** between 2018 and 2020. An increase of 7 percentage points to 16 percentage points was observed across

3 The tetrachoric correlation is a product–moment correlation between two observed binary variables that represent normally distributed continuous variables (Pearson, 1900). Further details on the definition and survey of the tetrachoric correlation can be found in Chapter 7.

Table 3.1: Percentages of teachers who reported that they have never used ICT during lessons and when preparing lessons

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
During lessons	0	0	0	-	1	0	-1*	.91**	9	3	-6**	.73**
	(-)	(-)	(-)		(0.4)	(0.2)	(0.3)	(.11)	(1.8)	(1.0)	(1.8)	(.13)
Preparing lessons	0	0	0	-	1	0	-1*	.78**	5	1	-4*	.22
	(-)	(-)	(-)		(0.3)	(0.1)	(0.3)	(.11)	(1.4)	(0.6)	(1.5)	(.21)

*Note: 18 = percentage of teachers who reported never using ICT for the activity in 2018; 20 = percentage of teachers who reported never using ICT for the activity in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Table 3.2: Percentages of teachers who reported using ICT every day

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
At school when teaching	73	88	16**	.51**	58	70	12**	.73**	18	28	10**	.65**
	(3.4)	(1.8)	(3.5)	(.09)	(1.3)	(1.4)	(1.5)	(.03)	(2.1)	(2.6)	(2.6)	(.07)
At school for other work-related purposes	95	95	0	.18	80	85	5**	.50**	34	48	14**	.35**
	(1.3)	(1.2)	(1.7)	(.17)	(1.1)	(1.1)	(1.4)	(.05)	(3.1)	(3.6)	(3.6)	(.08)
Outside school for work-related purposes	65	76	11**	.67**	56	63	7**	.61**	54	65	11**	.61**
	(3.4)	(3.2)	(2.6)	(.06)	(1.8)	(1.8)	(1.9)	(.03)	(3.3)	(3.1)	(2.9)	(.05)
Outside school for non-work-related purposes	87	87	0	.59**	76	79	2	.58**	60	59	-1	.42**
	(1.8)	(1.6)	(2.1)	(.08)	(1.2)	(1.2)	(1.5)	(.04)	(3.0)	(3.2)	(4.0)	(.08)

*Note: 18 = percentage of teachers who reported using ICT every day for the activity in 2018; 20 = percentage of teachers who reported using ICT every day for the activity in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

the countries in the 2020 teacher responses on everyday usage of ICT for these purposes, compared to the responses in 2018. The daily use of ICT ***at school for other work-related purposes*** increased significantly in Uruguay (14 percentage points) and in Finland (5 percentage points) but did not change significantly in Denmark, where the percentage in 2018 was already extremely high (95%).

Teachers' use of computers in 2018 is strongly correlated with their use of computers in 2020 for most purposes. This result means that teachers who used ICT frequently during the pandemic in 2020 were already frequent users of ICT in 2018.

Teachers' ICT-related self-efficacy

Self-efficacy is considered an important determinant of behavior. In the ICILS teachers questionnaires, teachers were asked about their self-efficacy related to the use of ICT. For each statement, the teachers had to indicate how well they can do certain activities such as using the internet to search for information, or how well they could use spreadsheets. Teachers could rate how well they can do a range of different ICT tasks using the following categories: "I know how to do this", "I haven't done this but I could find out

how", and "I do not think I could do this". The percentages of teachers who reported that they knew how to do each of the tasks are presented in Table 3.3.

Table 3.3: Percentages of teachers who reported that they know how to do different ICT tasks

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Find useful teaching resources on the Internet	99 (0.8)	99 (0.4)	0 (0.9)	-	97 (0.6)	97 (0.5)	0 (0.5)	.76** (.07)	94 (1.1)	95 (1.4)	1 (1.8)	.42* (.20)
Contribute to a discussion forum/ user group on the Internet	54 (3.1)	60 (3.0)	6 (4.2)	.50** (.09)	73 (1.5)	78 (1.3)	5** (1.3)	.61** (.04)	56 (3.6)	65 (2.7)	9** (3.2)	.63** (.07)
Produce presentations with simple animation functions	93 (1.2)	92 (1.5)	-1 (1.6)	.61** (.11)	76 (1.4)	77 (1.5)	1 (1.4)	.77** (.03)	86 (1.8)	88 (1.9)	2 (2.0)	.75** (.08)
Use the Internet for online purchases and payments	99 (0.5)	99 (0.8)	0 (0.9)	-	98 (0.5)	98 (0.5)	0 (0.5)	.75** (.09)	83 (1.9)	85 (1.9)	2 (2.4)	.51** (.10)
Prepare lessons that involve the use of ICT by students	98 (0.7)	97 (1.3)	-2 (1.4)	.11 (.14)	86 (1.1)	89 (1.0)	4** (1.1)	.67** (.04)	79 (2.1)	88 (2.0)	9** (2.3)	.76** (.06)
Use a spreadsheet program for keeping records or analyzing data	65 (2.3)	69 (2.4)	4 (2.1)	.82** (.06)	55 (1.6)	55 (1.5)	1 (1.2)	.87** (.02)	69 (2.5)	77 (2.4)	7** (2.7)	.67** (.06)
Assess student learning	83 (2.8)	89 (1.8)	6* (2.4)	.54** (.10)	78 (1.3)	86 (1.1)	8** (1.1)	.51** (.05)	73 (2.6)	85 (1.9)	12** (2.9)	.59** (.08)
Collaborate with others using shared resources	80 (3.0)	87 (2.0)	7** (2.6)	.67** (.08)	64 (1.7)	75 (1.7)	10** (1.4)	.77** (.03)	64 (3.0)	77 (2.3)	13** (3.3)	.68** (.07)
Use a learning management system	81 (3.3)	86 (2.7)	5 (3.3)	.59** (.09)	62 (1.8)	66 (2.0)	4* (1.7)	.71** (.03)	62 (3.3)	92 (1.7)	29** (2.9)	.61** (.10)

*Note: 18 = percentage of teachers who reported knowing how to do the ICT task in 2018; 20 = percentage of teachers who reported knowing how to do the ICT task in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Between 2018 and 2020, there was either no change or significant but small changes in the percentages of teachers reporting that they knew how to complete the various ICT tasks listed in the questionnaire. However, for two tasks, a significant change was observed in all participating countries. These tasks are related to ***assessing student learning*** and ***collaborating with others using shared resources***. In both instances, the percentage of teachers who reported that they knew how to do the tasks was significantly higher in 2020 than in 2018.

The increases from 2018 to 2020, in teachers' reporting that they knew how to use ICT to ***assess student learning*** were 6 percentage points in Denmark, 8 percentage points in Finland, and 12 percentage points in Uruguay. Similar increases of 7 percentage points, 10 percentage points and 13 percentage points respectively, were found in teachers' answers on whether they use ICT to ***collaborate with others using shared resources***. An increase between 2018 and 2020 was also observed in Finland and Uruguay for using ICT to ***contribute to a discussion forum or user group on the Internet***, ***prepare lessons that involve the use of ICT by students*** and ***use a learning management system***. In addition, in Uruguay, between 2018 and 2020 a significant increase was observed in teachers reporting that they knew how to use ICT to ***use of a spreadsheet program for keeping records or analyzing data***.

In general, most of the changes between 2018 and 2020 were observed in Uruguay, and the fewest changes were observed in Denmark. The greatest change in teachers' ICT-related self-efficacy was observed in Uruguay, related to the use of a learning management system. About one third of teachers felt

more confident in using ICT in 2020 compared to in 2018.

Teachers' views on using ICT in teaching and learning

In contrast to the increased use of ICT for learning and teaching, the ICILS Teacher Panel data provides evidence that there has been little change in teachers' general attitudes about the advantages and disadvantages of using ICT for learning and teaching. This finding suggests that teachers used ICT more often not because their beliefs toward ICT have changed, but because COVID-19 related constraints have limited the continuation of normal on-site teaching.

Teacher attitudes about ICT are important to consider as they are related to their ICT use. ICILS asks teachers about their level of agreement or disagreement on a number of statements related to the effects of using ICT in teaching and learning. Seven of these statements relate to positive outcomes of using ICT in education, while six statements refer to outcomes that reflect potential impediments to student learning, when using ICT. The response options are "strongly agree," "agree," "disagree," or "strongly disagree". The percentages of teachers that agreed or strongly agreed with the positive outcome statements in 2018 and 2020 are presented in Table 3.4. The percentages of teachers that agreed or strongly agreed with the potential ICT-related impediments to learning in 2018 and 2020 are presented in Table 3.5.

In general, only a few significant changes were observed for the statements and no consistent change was observed across the countries. For the positive outcome statements (see Table 3.4) in Denmark, the only significant change between 2018 and 2020 was an increase in the level of agreement (7 percentage points) for the statement that ICT ***helps students to work at a level appropriate to their learning needs***. In Finland, agreement with this statement also increased significantly (5 percentage points). Furthermore, in Finland, a significant increase was observed for the levels of agreement levels on the following two statements: ***helps students develop problem-solving skills*** (5 percentage points) and ICT ***improves academic performance***

Table 3.4: Percentages of teachers agreeing with statements about positive outcomes of using ICT for teaching and learning

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Helps students develop greater interest in learning	85 (2.2)	82 (2.5)	-2 (2.6)	.63** (.08)	83 (1.1)	85 (1.2)	2 (1.2)	.64** (.05)	87 (2.2)	87 (2.9)	0 (2.9)	.55** (.11)
Helps students to work at a level appropriate to their learning needs	86 (2.9)	93 (1.3)	7* (3.3)	.24 (.15)	73 (1.6)	79 (1.2)	5** (1.6)	.48** (.04)	79 (3.1)	85 (2.4)	6 (3.5)	.42** (.14)
Helps students develop problem-solving skills	73 (3.6)	70 (3.5)	-2 (3.0)	.53** (.08)	60 (1.5)	65 (1.6)	5** (1.8)	.56** (.04)	75 (3.2)	81 (2.4)	6 (3.3)	.44** (.10)
Enables students to collaborate more effectively	68 (3.4)	72 (3.1)	4 (3.5)	.34** (.11)	72 (1.4)	73 (1.4)	1 (1.9)	.41** (.05)	70 (3.3)	71 (3.2)	1 (3.3)	.41** (.13)
Helps students develop skills in planning/self-regulation of work	64 (3.7)	67 (3.0)	3 (3.7)	.40** (.09)	62 (1.7)	61 (1.4)	-1 (1.9)	.38** (.05)	63 (3.7)	75 (2.9)	12** (3.4)	.50** (.10)
Improves academic performance of students	77 (2.7)	72 (2.8)	-4 (2.9)	.48** (.09)	45 (1.7)	49 (1.6)	3* (1.6)	.57** (.04)	64 (4.1)	70 (2.9)	6 (3.2)	.51** (.09)
Enables students to access better sources of information	92 (1.6)	95 (1.7)	3 (2.5)	.15 (.17)	95 (0.6)	96 (0.5)	1 (0.8)	.46** (.10)	84 (2.5)	84 (2.6)	0 (3.2)	.43** (.14)

*Note: 18 = percentage of teachers who agreed with the statement in 2018; 20 = percentage of teachers who agreed with the statement in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Table 3.5: Percentages of teachers agreeing with statements about negative outcomes of using ICT for teaching and learning

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Impedes concept formation by students	17 (2.0)	12 (1.6)	-5* (2.1)	.53** (.11)	19 (1.2)	17 (1.2)	-2 (1.4)	.61** (.04)	5 (1.5)	10 (2.0)	4 (2.3)	.56** (.13)
Results in students copying material from Internet sources	46 (3.3)	51 (3.5)	5 (3.0)	.59** (.06)	74 (1.5)	77 (1.4)	3* (1.6)	.54** (.04)	54 (2.7)	55 (3.7)	1 (3.0)	.57** (.09)
Distracts students from learning	56 (3.7)	56 (3.3)	1 (2.1)	.74** (.05)	36 (1.8)	35 (1.8)	0 (1.7)	.58** (.03)	25 (2.8)	24 (2.3)	-1 (2.9)	.39** (.11)
Results in poorer written expression among students	44 (2.5)	42 (3.6)	-2 (3.2)	.53** (.08)	61 (1.6)	59 (1.5)	-2 (1.9)	.64** (.03)	37 (3.4)	36 (3.5)	0 (3.6)	.36** (.10)
Results in poorer calculation and estimation skills among students	27 (2.6)	31 (2.5)	4 (2.9)	.51** (.09)	39 (1.7)	38 (1.4)	-2 (1.9)	.53** (.04)	23 (2.1)	23 (2.7)	0 (2.9)	.51** (.09)
Limits the amount of personal communication among students	36 (3.6)	34 (3.5)	-2 (5.0)	.38** (.09)	38 (1.5)	34 (1.3)	-4* (1.8)	.50** (.04)	32 (3.5)	36 (3.1)	4 (3.7)	.39** (.10)

*Note: 18 = percentage of teachers who agreed with the statement in 2018; 20 = percentage of teachers who agreed with the statement in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

of students (3 percentage points). The only significant change in Uruguay (an increase of 12 percentage points) was observed for the level of agreement for the statement that ICT ***helps students develop skills in planning and self-regulation of their work***. This was the only change across all countries and statements between 2018 and 2020 that exceeded 10 percentage points. The correlation coefficients show a positive relationship in all statements between the years 2018 and 2020.

Regarding the potential impediment statements (see Table 3.5) in Denmark, a significant decrease in 2020 compared to 2018 was observed in the percentage of teachers who agreed or strongly agreed that using ICT for teaching and learning ***impedes concept formation by students***. In Finland, there was a significant increase in the percentage of teachers who agreed or strongly agreed that using ICT for teaching and learning ***results in students copying material from Internet sources*** and a significant decrease for the statement that using ICT for teaching and learning ***limits the amount of personal communication among students***. All of these changes were rather small and did not exceed 5 percentage points. In Uruguay, no significant change was observed. The correlation coefficients show a positive relationship in all statements between the years 2018 and 2020.

3.2.2 Teachers' perceptions of the school's ICT learning environments

There is strong evidence from the ICILS Teacher Panel that according to the participating teachers, ICT-resources have improved at their schools and likewise, there has been increased collaboration with their colleagues.

Teachers' perceptions of the availability of ICT resources at school

Teacher perceptions of ICT learning environments are an important indicator of school ICT resources. The ICILS teacher questionnaire collected data on teacher perceptions of ICT resources at their schools by asking teachers about their level of agreement or disagreement with a number of statements. The available response options were "strongly agree," "agree," "disagree," or "strongly disagree". The percentages of teachers who agreed or strongly agreed with each of these statements are presented in Table 3.6.

Table 3.6: Percentages of teachers agreeing with statements about the availability of ICT for teaching at school

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
ICT is considered a priority for use in teaching	97 (1.1)	100 (0.5)	3* (1.2)	-	90 (0.9)	95 (0.7)	4** (1.0)	.65** (.06)	68 (3.5)	78 (3.0)	10** (3.7)	.51** (.09)
My school has sufficient ICT equipment (e.g. computers)	74 (3.0)	86 (2.1)	11** (2.9)	.49** (.08)	48 (2.1)	67 (2.4)	18** (2.4)	.48** (.06)	41 (3.8)	48 (3.0)	7 (4.0)	.37** (.09)
The computer equipment in our school is up-to-date	71 (3.5)	82 (2.3)	11** (3.6)	.50** (.08)	59 (2.3)	72 (2.3)	13** (2.5)	.38** (.05)	44 (3.5)	57 (3.0)	13** (3.2)	.51** (.07)
My school has access to sufficient digital learning resources	78 (2.8)	81 (3.1)	3 (2.5)	.73** (.07)	55 (2.1)	71 (1.8)	16** (2.0)	.48** (.04)	41 (3.8)	52 (2.9)	11** (3.4)	.45** (.08)
My school has good connectivity (e.g., fast speed) to the Internet	69 (3.2)	85 (2.6)	16** (3.4)	.62** (.08)	60 (2.3)	69 (1.8)	9** (2.4)	.53** (.04)	24 (3.2)	57 (3.7)	33** (4.0)	.36** (.10)
There is enough time to prepare lessons that incorporate ICT	34 (3.5)	51 (3.5)	16** (2.8)	.79** (.04)	26 (1.5)	39 (1.7)	12** (1.6)	.60** (.04)	25 (3.1)	30 (3.1)	6 (3.5)	.59** (.09)
There is sufficient opportunity for me to develop expertise in ICT	40 (3.4)	48 (3.8)	8* (3.2)	.66** (.06)	57 (2.0)	66 (1.8)	9** (2.0)	.50** (.04)	41 (3.3)	50 (3.1)	8* (3.9)	.51** (.09)
There is sufficient technical support to maintain ICT resources	56 (3.6)	64 (3.5)	9** (3.3)	.60** (.06)	59 (2.3)	68 (2.0)	9** (2.2)	.51** (.05)	34 (3.9)	48 (3.1)	13** (4.5)	.42** (.09)

*Note: 18 = percentage of teachers who agreed with the statement in 2018; 20 = percentage of teachers who agreed with the statement in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Overall, we see a significant increase in the level of agreement with almost all statements related to the availability of ICT for teaching at school, in the three countries. The only change between 2018 and 2020 that was not significant in Denmark is the percentage of teachers that agreed or strongly agreed that ***my school has access to sufficient digital learning resources*** and in Uruguay, for the statements that ***my school has sufficient ICT equipment (e.g., computers)*** and that ***there is enough time to prepare lessons that incorporate ICT***. On the other hand, the significant increase in statements ranges from 3 percentage points to 16 percentage points in Denmark, from 4 percentage points to 18 percentage points in Finland and 8 percentage points to 33 percentage points in Uruguay. In Denmark and Uruguay, the largest significant increases in the level of agreement were observed on the statement ***my school has good connectivity (e.g. fast speed) to the Internet***. In Denmark an increase of 16 percentage points and in Uruguay 33 percentage points was observed for teachers' level of agreement with this statement in 2020 compared to 2018. In Finland, the largest increase in the level of agreement was observed for the statement that ***my school has sufficient ICT equipment (e.g. computers)***.

Collaboration between teachers in using ICT

A consistent finding reported across ICILS 2013 and 2018 was that teachers who reported working in schools where they felt there was a collaborative environment with respect to the use of ICT in teaching, were more likely to use digital literacy skills in their own teaching (Fraillon et al., 2019). The teachers were asked about their perceptions of whether and how ICT was used regarding collaboration with their colleagues in teaching and learning at their schools. The teachers had to express their agreement or disagreement with five statements regarding the collaborative use of ICT with colleagues. Possible response options were "strongly agree," "agree," "disagree," or "strongly disagree". Results are presented as the percentages of teachers who agreed or strongly agreed with each of the statements related to teacher

collaboration. The results are located in Table 3.7.

Table 3.7: Percentages of teachers agreeing with statements about the collaborative use of ICT in teaching and learning

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
I work with other teachers on improving the use of ICT in class	63 (3.9)	71 (3.1)	8* (3.3)	.56** (.07)	68 (1.5)	71 (1.5)	3 (1.6)	.60** (.04)	70 (3.0)	80 (2.4)	10** (3.7)	.38** (.10)
I collaborate with colleagues to develop ICT-based lessons	59 (3.2)	63 (3.6)	5 (3.7)	.39** (.09)	55 (1.8)	64 (1.6)	8** (2.0)	.57** (.04)	66 (3.5)	79 (2.2)	13** (4.0)	.34** (.08)
I observe how other teachers use ICT in teaching	54 (3.4)	62 (2.6)	8* (3.2)	.39** (.07)	75 (1.3)	75 (1.3)	1 (1.5)	.57** (.05)	81 (2.4)	89 (1.9)	9** (3.0)	.11 (.13)
I discuss with other teachers how to use ICT in teaching topics	75 (2.5)	78 (2.5)	3 (2.7)	.46** (.08)	79 (1.2)	77 (1.3)	-2 (1.6)	.54** (.04)	87 (2.3)	92 (2.0)	5* (2.3)	.24 (.16)
I share ICT-based resources with other teachers in my school	79 (2.4)	87 (2.2)	8** (2.3)	.67** (.09)	55 (1.3)	64 (1.4)	8** (1.8)	.62** (.03)	81 (1.8)	89 (2.0)	8** (2.8)	.38** (.11)

*Note: 18 = percentage of teachers who agreed with the statement in 2018; 20 = percentage of teachers who agreed with the statement in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

We observed a significant increase in the level of agreement for different statements across the countries. The only consistent significant change across all countries was for the statement relating to ***sharing ICT-based resources with other teachers in my school***. Across the countries, an increase of about 8 percentage points was observed for teachers' level of agreement with this statement in 2020 compared to 2018. A significant increase in the level of agreement for the statements ***I work together with other teachers on improving the use of ICT in classroom teaching*** and ***I observe how other teachers use ICT in teaching*** was observed in Denmark and Uruguay. In addition, a significant increase in the level of agreement for the statement ***I collaborate with colleagues to develop ICT-based lessons*** was observed in Finland and Uruguay. Finally, the increase in teachers' level of agreement for the statement ***I discuss with other teachers how to use ICT in teaching topics*** was significant in Uruguay only. The change of magnitude in all these statements was between 4 percentage points and 13 percentage points. The correlation coefficients show a positive relationship in all statements between years 2018 and 2020, and are the lowest in Uruguay.

3.2.3 Teachers' emphasis on learning CIL and CT in their reference class

To capture teachers' ICT-related perceptions in their in-class teaching, the ICILS teacher questionnaire asked the emphasis teachers place on developing students' CIL and CT, and their relationship with the actual use of ICT in a randomly-selected ***reference class***. Teachers were asked to identify the ***reference class***. In ICILS 2018, the ***reference class*** was defined as the first grade eight class taught by the teacher the last Tuesday (or on the next day in the week they were teaching if they did not have classes on Tuesday) before they took the questionnaire. In the ICILS Teacher Panel, the ***reference class*** was defined as the first grade eight (or equivalent) class taught by the teacher last Tuesday. Further details on the definition and survey of the reference class are elaborated in Chapter 5. A reference to the grade was important because it can be assumed that teachers do not give the same weight to CIL and CT in different grades. For the same reason, the reference class has also been referred to in the following questions. The distributions of reference grade into which the class falls, and the corresponding subject, can also be found in Chapter 5.

Teachers' emphasis on developing CIL-related skills

Teachers were asked how important it is to them that their students in the reference class develop CIL skills. The possible response options to this question were "strong emphasis," "some emphasis," "little emphasis," or "no emphasis". The results are presented as the percentages of teachers who reported some or strong emphasis for each of these statements. The percentages and the change in percentages between the years across countries are presented in Table 3.8.

Table 3.8: Percentages of teachers who reported giving some or strong emphasis to developing CIL-related skills in their reference class

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
To access information efficiently	86 (2.4)	89 (2.7)	3 (3.0)	.64** (.11)	73 (1.5)	77 (1.3)	3* (1.4)	.62** (.04)	83 (2.8)	95 (1.4)	12** (2.4)	.54** (.13)
To display information for a given audience/purpose	91 (2.1)	93 (1.8)	2 (2.9)	.45** (.17)	63 (1.6)	63 (1.6)	0 (1.6)	.62** (.04)	59 (2.7)	75 (3.0)	17** (3.5)	.33** (.11)
To evaluate the credibility of digital information	77 (2.6)	83 (2.0)	6* (2.6)	.51** (.13)	60 (1.5)	63 (1.7)	4* (1.5)	.62** (.04)	76 (2.6)	86 (2.5)	10** (3.5)	.43** (.12)
To share digital information with others	80 (3.0)	87 (2.2)	7* (2.9)	.64** (.11)	55 (1.9)	65 (2.0)	10** (2.0)	.57** (.04)	62 (2.9)	81 (2.6)	19** (3.8)	.36** (.10)
To use computer software to construct digital work products	85 (2.2)	90 (1.7)	5* (2.3)	.38* (.15)	61 (1.5)	66 (1.7)	5** (1.5)	.56** (.04)	60 (2.6)	76 (2.7)	16** (3.1)	.41** (.09)
To provide digital feedback on the work of other classmates	34 (2.2)	45 (3.0)	11** (3.3)	.60** (.07)	19 (1.4)	26 (1.6)	6** (1.8)	.50** (.05)	25 (2.7)	56 (2.8)	31** (3.6)	.36** (.08)
To explore a range of digital resources when searching for info.	74 (2.4)	78 (2.5)	4 (3.2)	.39** (.10)	48 (1.5)	55 (1.6)	7** (1.6)	.55** (.04)	67 (3.4)	87 (2.1)	20** (3.2)	.58** (.09)
To provide references for digital information sources	65 (2.7)	70 (2.8)	4 (2.7)	.63** (.07)	37 (1.7)	44 (1.6)	7** (1.6)	.59** (.03)	69 (2.2)	82 (1.9)	13** (2.8)	.51** (.09)
To understand the consequences of making info. available online	62 (2.8)	70 (2.8)	8* (4.2)	.49** (.09)	47 (1.4)	52 (1.7)	6** (1.8)	.57** (.04)	65 (2.9)	76 (2.4)	11** (3.9)	.43** (.10)

*Note: 18 = percentage of teachers who reported some or strong emphasis on developing students' CIL skill in 2018; 20 = percentage of teachers who reported some or strong emphasis on developing students' CIL skill in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Significant increases in the percentages of teachers reporting some or strong emphasis were observed for most statements across the countries. These increases were significant for all the statements in Uruguay, and all but one statement in Finland, relating to ***displaying information for a given audience or purpose***. The change in this statement was also not significant in Denmark. In addition, non-significant changes in Denmark were observed for statements that relate to ***accessing information efficiently***, ***exploring a range of digital resources when searching for information*** and ***providing references for digital information sources***.

To sum up, overall, the significant increases range from 5 percentage points to 11 percentage points in Denmark, from 3 percentage points to 10 percentage points in Finland and 11 percentage points to 31 percentage points in Uruguay. The largest increase was observed for the statement that relates to ***exploring a range of digital resources when searching for information***. In Uruguay, about one third more of the teachers gave this topic some or strong emphasis in 2020 compared to 2018.

Teachers' emphasis on developing CT-related skills

Teachers were asked about the emphasis they gave in their reference class to developing CT-related capabilities in their students. The possible response options were "strong emphasis," "some emphasis," "little emphasis," or "no emphasis". The results are presented as the percentages of teachers who reported some or strong emphasis for each of these statements. The percentages and the change between the years across countries is presented in Table 3.9.

Table 3.9: Percentages of teachers who reported giving some or strong emphasis to developing CT-related skills in their reference class

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
To display information in different ways	80 (2.3)	84 (2.4)	4 (3.0)	.47** (.13)	73 (1.3)	74 (1.8)	1 (1.8)	.58** (.04)	78 (2.7)	85 (2.4)	7* (3.2)	.41** (.13)
To break a complex process into smaller parts	68 (2.7)	77 (2.1)	9* (3.6)	.33** (.12)	68 (1.6)	70 (1.6)	2 (1.7)	.58** (.04)	73 (3.1)	77 (3.1)	4 (3.2)	.55** (.09)
To understand diagrams that describe real-world problems	60 (3.2)	63 (3.2)	3 (2.6)	.71** (.06)	44 (1.4)	49 (1.4)	6** (1.6)	.66** (.04)	63 (3.0)	63 (2.8)	0 (3.0)	.62** (.07)
To plan tasks by setting out the steps needed to complete them	70 (3.1)	76 (3.6)	6 (3.9)	.29** (.10)	58 (1.7)	59 (1.6)	1 (1.8)	.49** (.04)	77 (2.6)	83 (2.2)	6* (2.9)	.65** (.09)
To use tools making diagrams that help solve problems	42 (2.6)	47 (2.5)	6 (3.1)	.60** (.06)	19 (1.1)	20 (1.3)	2 (1.2)	.54** (.06)	47 (3.5)	50 (3.3)	3 (4.7)	.44** (.09)
To use simulations to understand or solve real-world problems	30 (2.3)	34 (2.6)	4 (3.0)	.63** (.06)	18 (1.1)	21 (1.4)	3** (1.3)	.52** (.05)	45 (3.5)	47 (3.3)	2 (4.3)	.43** (.07)
To make flow diagrams to show the different parts of a process	12 (1.8)	14 (2.1)	2 (2.7)	.42** (.11)	7 (0.8)	10 (1.0)	3** (1.2)	.40** (.07)	36 (3.1)	39 (3.3)	3 (4.7)	.34** (.12)
To record and evaluate data to understand and solve a problem	47 (3.2)	50 (3.1)	3 (3.5)	.50** (.08)	60 (1.6)	60 (2.0)	0 (2.0)	.54** (.04)	58 (3.2)	58 (3.2)	1 (4.5)	.37** (.08)
To use real-world data to review and revise solutions to problems	61 (2.7)	59 (3.3)	-1 (2.8)	.57** (.07)	55 (1.4)	52 (1.6)	-3 (1.6)	.56** (.04)	62 (3.1)	67 (3.0)	5 (4.1)	.53** (.07)

*Note: 18 = percentage of teachers who reported some or strong emphasis on developing students' CT skill in 2018; 20 = percentage of teachers who reported some or strong emphasis on developing students' CT skill in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

In contrast to the emphasis on CIL-related skills, the changes in emphasis on CT-related skills were mostly non-significant. No consistent significant changes were observed across the countries. The only significant change in Denmark, was observed for emphasis on ***breaking a complex process into smaller parts***. An increase of about 9 percentage points was observed from the teacher responses, giving this topic some or strong emphasis in 2020 compared to 2018. In Finland, the only significant changes relate to ***understanding diagrams that describe or show real-world problems***, ***using simulations to help understand or solve real-world problems*** and ***making flow diagrams to show the different parts of a process***. The increases ranged from 3 percentage points to 6 percentage points. In Uruguay, significant increases were observed between 2018 and 2020 for emphasis on ***displaying information in different ways*** (7 percentage points) and ***planning tasks by setting out the steps needed to complete them*** (6 percentage points).

3.2.4 Teachers' use of ICT for teaching and learning in their reference class

Teachers' use of ICT tools

One of the key findings of the ICILS Teacher Panel is that teachers in all participating countries have been using computers and information technology for learning and teaching much more frequently in their reference class since the outbreak of COVID-19 compared to before. In particular, learning management systems and collaborative software were used much more often to share learning material and to communicate with students.

The use of ICT for teaching and learning included the use of utility software and the use of digital tools when teaching the nominated reference class. The teachers were asked to rate the frequency of their use of these tools in the reference class during the current school year. The available response options were "never," "in some lessons," "in most lessons," or "in every, or almost every lesson". Results for the use of general utility software are presented in Table 3.10 and results for teachers' use of digital learning tools in Table 3.11. The percentages of teachers who reported using the software and tools in most lessons, almost every, or every lesson are shown together with the change in percentages between 2018 and 2020 and the correlation coefficients.

In Table 3.10 we observed few significant changes in Denmark and Finland, whereas a significant increase was present regarding the use of all general ICT utility tools in Uruguay. A consistent significant change that was observed in all countries was the increase in using ***communication software***. An increase of about 8 percentage points for teachers in Denmark, 6 percentage points in Finland, and 35 percentage points in Uruguay were observed in the responses about the ***communication software*** used in most of the lessons in 2020 compared to 2018. In addition, we observed in Denmark a significant increase in the use of ***word-processing software*** (8 percentage points) and in Finland a significant increase in the use

Table 3.10: Percentages of teachers who reported using general utility ICT tools in most lessons, almost every, or every lesson

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Word-processing software (e.g., [Microsoft Word®])	63 (3.3)	71 (2.8)	8* (3.8)	.52** (.09)	28 (1.3)	30 (1.4)	2 (1.3)	.59** (.04)	26 (2.6)	44 (3.5)	18** (3.0)	.60** (.07)
Presentation software (e.g., [Microsoft PowerPoint®])	32 (3.1)	35 (3.0)	3 (3.5)	.47** (.09)	29 (1.3)	30 (1.5)	2 (1.6)	.63** (.04)	21 (2.3)	31 (2.8)	10** (2.9)	.56** (.09)
Spreadsheets (e.g., [Microsoft Excel®])	17 (2.0)	15 (2.1)	-2 (2.5)	.60** (.08)	4 (0.7)	4 (0.5)	0 (0.8)	.54** (.10)	13 (1.7)	14 (2.0)	0 (2.0)	.68** (.10)
Video and photo software for capture and editing (e.g., iMovie)	5 (1.2)	6 (1.5)	1 (1.9)	.37* (.15)	5 (0.6)	4 (0.6)	-1 (0.6)	.73** (.07)	12 (1.6)	19 (2.2)	8** (2.1)	.54** (.11)
Communication software (e.g., email, direct messaging, Skype)	11 (1.6)	19 (2.1)	8** (2.6)	.11 (.13)	25 (1.4)	31 (1.3)	6** (1.3)	.44** (.04)	14 (2.1)	49 (3.1)	35** (3.6)	.27** (.10)
Computer-based information resources (e.g., websites, wikis)	41 (2.8)	39 (2.7)	-2 (3.4)	.44** (.09)	37 (1.6)	37 (1.4)	1 (1.8)	.54** (.04)	31 (3.0)	45 (2.9)	13** (3.1)	.51** (.08)
Digital contents linked with textbooks	16 (2.2)	20 (1.7)	4 (2.5)	.31** (.09)	32 (1.6)	42 (1.6)	10** (1.8)	.54** (.04)	18 (2.1)	40 (2.6)	22** (2.7)	.55** (.09)

*Note: 18 = percentage of teachers who reported using the ICT tool in 2018; 20 = percentage of teachers who reported using the ICT tool in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

of ***digital contents linked with textbooks*** (10 percentage points). In Uruguay, the only change that was not significant was the change in use of ***spreadsheets***. The change was the largest for the use of ***communication software*** (35 percentage points increase) and ***digital contents linked with textbooks*** (22 percentage points increase). The correlation coefficients were significant in all countries and statements, but for the use of ***communication software*** in Denmark, which suggests that in Denmark different teachers reported frequent use of communication software in 2018 compared to 2020.

A consistent change was observed in two statements across the countries in the use of digital learning tools, as presented in Table 3.11. Teachers in Denmark, Finland, and Uruguay reported an increase in the use of ***a learning management system*** and ***collaborative software***. An increase of about 11 percentage points to 13 percentage points in Denmark, 6 percentage points to 9 percentage points in Finland and 17 percentage points to 60 percentage points in Uruguay was observed for the use of these tools in most of the lessons in 2020 compared to 2018. In addition, in Finland and Uruguay, a small but significant increase was observed in the use of ***practice programs***, ***digital learning games*** and ***interactive digital learning resources***. Furthermore, in Uruguay, a significant increase in the use of ***concept mapping software***, ***e-portfolios*** and ***social media*** was observed. The largest increases in teachers' reported use of digital learning tools in most of the lessons were observed in Uruguay for the use of ***a learning management system*** (60 percentage points) and ***e-portfolios*** (53 percentage points).

Table 3.11: Percentages of teachers who reported using digital learning ICT tools in most lessons, almost every, or every lesson

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Practice programs/apps where you ask students questions	9 (1.6)	8 (1.5)	-1 (1.8)	.53** (.11)	13 (1.2)	17 (1.0)	3** (1.3)	.68** (.05)	9 (1.9)	16 (2.1)	8** (2.6)	.44** (.12)
Digital learning games	5 (1.2)	5 (1.1)	0 (1.3)	.58** (.14)	6 (0.8)	8 (0.8)	3** (1.0)	.62** (.06)	8 (1.7)	14 (2.3)	6** (2.3)	.53** (.15)
Concept mapping software (e.g., [Inspiration®], [Webspiration®])	3 (1.0)	3 (0.9)	1 (1.4)	.03 (.16)	1 (0.3)	1 (0.3)	0 (0.5)	.30 (1.30)	5 (1.1)	10 (1.7)	5** (1.9)	.48** (.14)
Simulations and modelling software (e.g., [NetLogo])	3 (1.0)	3 (0.8)	-1 (1.1)	.46** (.14)	2 (0.4)	3 (0.5)	1 (0.6)	.66** (.10)	4 (1.3)	6 (1.4)	2 (1.4)	.51** (.15)
A learning management system (e.g., [Edmodo], [Blackboard])	33 (3.6)	47 (4.1)	13** (3.5)	.75** (.05)	55 (1.7)	64 (1.5)	9** (2.1)	.35** (.04)	13 (2.0)	73 (3.0)	60** (3.6)	.36** (.14)
Collaborative software (e.g., [Google Docs®], [Onenote])	26 (2.8)	38 (3.7)	11** (2.2)	.66** (.07)	13 (1.2)	19 (1.4)	6** (1.4)	.60** (.05)	14 (2.4)	31 (2.9)	17** (3.2)	.55** (.09)
Interactive digital learning resources (e.g., learning objects)	48 (3.2)	53 (2.7)	5 (2.7)	.56** (.07)	6 (0.8)	11 (0.9)	5** (1.1)	.45** (.09)	16 (2.4)	29 (2.7)	13** (3.2)	.25* (.12)
Graphing or drawing software	8 (1.5)	10 (1.7)	2 (2.0)	.49** (.11)	3 (0.4)	3 (0.6)	1 (0.6)	.69** (.08)	15 (2.1)	16 (1.9)	1 (2.5)	.50** (.12)
e-portfolios (e.g., [VoiceThread])	1 (0.5)	2 (0.7)	1 (0.9)	.37* (.18)	5 (0.9)	5 (0.9)	1 (0.9)	.65** (.09)	15 (2.4)	68 (2.9)	53** (4.2)	.16 (.14)
Social media (e.g., [Facebook, Twitter])	5 (1.8)	5 (1.2)	0 (1.9)	.35** (.12)	4 (0.5)	4 (0.6)	1 (0.7)	.49** (.10)	7 (1.4)	16 (2.7)	9** (3.3)	.29* (.14)

*Note: 18 = percentage of teachers who reported using the digital learning tool in 2018; 20 = percentage of teachers who reported using the digital learning tool in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Teachers' use of ICT for classroom activities

The ICILS teacher questionnaire included a question about the extent to which ICT was used for different types of learning activities in the reference class. Teachers were asked to provide information about whether their students engaged in a range of activities, and how often the students used ICT as part of these activities. The possible response options were "they do not engage in this activity," "they never use ICT in this activity," "they sometimes use ICT in this activity," "they often use ICT in this activity," and "they always use ICT in this activity". Table 3.12 contains the percentages of teachers who reported that their

Table 3.12: Percentages of teachers who reported that students used ICT often or always when engaging in different classroom activities

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Work on extended projects (i.e., lasting over a week)	88 (2.3)	92 (1.7)	3 (2.1)	.19 (.17)	40 (2.1)	42 (2.1)	2 (2.2)	.48** (.06)	53 (3.8)	62 (3.1)	9* (4.4)	.45** (.13)
Work on short assignments (i.e., within one week)	88 (2.0)	91 (1.7)	2 (2.1)	.32* (.14)	45 (2.0)	50 (1.7)	6** (1.9)	.48** (.05)	46 (3.6)	67 (3.5)	21** (4.4)	.32** (.10)
Explain and discuss ideas with other students	44 (3.2)	53 (2.8)	9* (3.6)	.35** (.08)	13 (1.3)	16 (1.4)	3* (1.5)	.50** (.07)	29 (3.2)	46 (3.4)	17** (4.0)	.25* (.12)
Submit completed work for assessment	82 (2.3)	88 (1.9)	6* (2.8)	.15 (.17)	37 (2.3)	57 (2.0)	19** (2.3)	.45** (.05)	38 (2.9)	67 (3.4)	28** (4.1)	.25* (.11)
Work individually on learning materials at their own pace	75 (3.5)	85 (2.2)	10** (2.8)	.40** (.11)	32 (1.7)	41 (1.7)	9** (1.8)	.44** (.05)	35 (3.2)	64 (3.4)	29** (3.8)	.33** (.10)
Undertake open-ended investigations or field work	55 (3.3)	61 (3.5)	6 (4.0)	.43** (.11)	21 (1.6)	23 (1.7)	2 (1.7)	.42** (.07)	35 (3.5)	51 (4.2)	16** (4.8)	.30** (.11)
Reflect on their learning experiences (e.g., by using a log)	39 (2.7)	48 (3.6)	10* (4.0)	.28** (.10)	12 (1.8)	21 (2.0)	9** (2.6)	.40** (.10)	19 (3.1)	37 (3.6)	18** (4.4)	.29* (.14)
Communicate with students in other schools on projects	49 (2.5)	66 (3.0)	17** (3.1)	.40** (.09)	16 (1.6)	21 (1.8)	5* (2.0)	.42** (.08)	30 (4.2)	57 (4.8)	28** (4.0)	.56** (.10)
Plan a sequence of learning activities for themselves	43 (3.1)	54 (3.5)	11** (3.9)	.29** (.10)	8 (1.8)	12 (1.7)	4* (1.9)	.57** (.10)	31 (3.5)	42 (4.3)	12* (5.9)	.05 (.14)
Analyze data	62 (3.7)	68 (2.6)	6 (3.5)	.40** (.08)	20 (1.7)	24 (1.5)	4 (2.1)	.45** (.06)	34 (3.3)	45 (3.7)	10* (4.2)	.28* (.11)
Evaluate information resulting from a search	62 (2.7)	65 (2.8)	3 (3.5)	.46** (.09)	23 (1.6)	27 (1.6)	5** (1.7)	.55** (.05)	34 (3.3)	48 (3.7)	14** (3.6)	.41** (.09)
Collect data for a project	81 (2.3)	77 (2.9)	-4 (3.6)	.16 (.10)	50 (1.8)	48 (1.7)	-2 (2.0)	.46** (.05)	48 (3.1)	60 (3.4)	12** (3.7)	.47** (.11)
Create visual products or videos	83 (2.2)	84 (2.7)	1 (2.0)	.53** (.09)	33 (2.2)	36 (1.6)	3 (1.8)	.48** (.05)	42 (3.7)	59 (3.4)	17** (3.9)	.48** (.09)
Share products with other students	75 (3.3)	83 (2.4)	7* (3.1)	.29* (.14)	26 (2.0)	32 (1.8)	7** (1.9)	.47** (.05)	38 (3.9)	55 (3.3)	17** (4.5)	.30** (.11)

Note: 18 = percentage of teachers who reported that students used ICT in 2018; 20 = percentage of teachers who reported that students used ICT in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse.
*$p < .05$, **$p < .01$.

students often or always used ICT for different class activities in 2018 and 2020. Data from teachers who indicated that their students had not engaged in each of these activities were removed from the analysis.

Between 2018 and 2020, a consistent increase was observed in the percentages of teachers reporting that their students used ICT often or always for the following seven activities: ***explain and discuss ideas with other students***, ***submit completed work for assessment***, ***work individually on learning materials at their own pace***, ***reflect on their learning experience***, ***communicate with other students on projects***, ***plan a sequence of learning activities for themselves*** and ***share products with other students***. Across these activities, the increases ranged from 6 percentage points to 17 percentage points in Denmark, from 3 percentage points to 19 percentage points in Finland, and from 9 percentage points to 29 percentage points in Uruguay. The largest reported increases in students' use of ICT in Denmark, was observed for ***communication with other students on projects***, in Finland, was observed for ***submission of completed work for assessment*** and in Uruguay, were observed for ***submission of completed work for assessment***, ***communication with other students in other schools on projects*** and ***working individually on leaning materials at their own pace***. In general, we observed more and larger changes in Uruguay than in Denmark and Finland. The correlation coefficients are positive for all the statements in all participating countries, and significant for most statements within the countries.

Teachers' use of ICT for teaching practices

The ICILS teacher questionnaire collected data on teachers' use of a range of teaching practices and the frequency of use of ICT for different teaching practices in the reference class. The available response options were "I do not use this practice with the reference class," "I never use ICT with this practice," "I sometimes use ICT with this practice," "I often use ICT with this practice," or "I always use ICT with this practice". The results are presented in Table 3.13 as percentages of the teachers who reported to use ICT often or always, taken from the teachers who reported using each of these practices. Teachers who did not use the practice with the reference class were excluded from the analysis.

We observed a significant increase in ICT use for most practices in Denmark and Finland. The only changes that were not significant were observed for the following activities: ***enabling student-led whole class discussions***, ***communication with parents***, and ***supporting inquiry learning***. The largest significant increase between 2018 and 2020 in Denmark and Finland, was observed for ***the provision of feedback to students on their work***. This increase was about 17 percentage points in Denmark and 14 percentage points in Finland. Among teachers who indicated that they used the specified practice with the reference class in Uruguay, the frequency of using ICT significantly increased for all teaching practices between 2018 and 2020. Also in Uruguay, the largest increase was observed for ***the provision of feedback to students on their work***. One third of teachers reported using ICT often or always in 2020 compared to 2018. The correlation coefficients are positive and significant for all the statements in all participating countries.

3.3 School principal survey

The ICILS school principal questionnaire asked about school characteristics, school approaches to CIL and CT learning, and schools' expectations and requirements of ICT use in teaching and learning. In this section, we report the results of analyses related to school principals' use of ICT for different school related activities, their views on using ICT for educational outcomes, schools' expectations of ICT use by teachers and teacher collaborations using ICT, and the priority given to different ways of facilitating the use of ICT in teaching and learning.

3.3.1 School principals' use of ICT

ICILS collected data from school principals' about their use of ICT for different school-related activities. The school principal questionnaire asked principals to indicate how often they used ICT for general school-related activities (Table 3.14) and for school-related communication activities (Table 3.15). For each item, the available response options were "never," "less than once a month," "at least once a month but not every week," "at least once a week but not every day," and "every day".

The responses to ten of the statements provided data on principals' use of ICT for general school-related activities. These results are presented in Table 3.14 as percentages of principals who reported using ICT

Table 3.13: Percentages of teachers who reported using ICT often or always for different teaching practices

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Presentation of information through direct class instruction	76 (3.3)	86 (2.2)	10** (3.0)	.40** (.12)	71 (1.3)	78 (1.0)	7** (1.5)	.59** (.04)	38 (3.0)	57 (2.9)	19** (3.3)	.61** (.07)
Provision of enrichment support to individual students or small groups	50 (3.2)	60 (3.2)	10** (3.7)	.50** (.07)	30 (2.0)	39 (2.2)	9** (2.8)	.37** (.05)	35 (3.0)	65 (3.1)	29** (3.2)	.49** (.08)
Support of student-led whole-class discussions and presentations	55 (3.1)	57 (3.0)	2 (3.3)	.30** (.08)	44 (1.9)	47 (2.3)	3 (2.5)	.34** (.05)	32 (2.9)	45 (3.6)	14** (4.0)	.45** (.10)
Assessment of students' learning through tests	68 (2.6)	76 (2.6)	9** (2.9)	.39** (.11)	24 (1.8)	32 (1.8)	8** (1.8)	.43** (.06)	33 (2.9)	56 (3.4)	22** (4.1)	.33** (.09)
Provision of feedback to students on their work	43 (3.6)	60 (3.6)	17** (3.1)	.50** (.07)	24 (1.7)	38 (1.8)	14** (2.2)	.45** (.06)	24 (2.4)	61 (3.2)	37** (4.0)	.32** (.10)
Reinforcement of learning of skills through repetition of examples	55 (3.7)	67 (2.6)	12** (3.3)	.27** (.08)	31 (1.6)	37 (1.6)	6** (2.1)	.44** (.05)	30 (2.7)	55 (3.0)	26** (3.3)	.42** (.08)
Support of collaboration among students	35 (3.1)	43 (3.4)	8* (3.8)	.37** (.09)	14 (1.1)	20 (1.7)	6** (1.9)	.46** (.07)	32 (3.2)	46 (3.0)	14** (3.3)	.62** (.07)
Mediation of communication between students and experts	43 (4.0)	57 (4.3)	14** (4.1)	.40** (.10)	18 (1.8)	24 (2.0)	5* (2.2)	.40** (.08)	18 (2.6)	38 (4.3)	19** (4.3)	.65** (.10)
Communication with parents about students' learning	62 (3.1)	66 (3.2)	4 (3.4)	.47** (.09)	80 (1.2)	80 (1.3)	0 (1.5)	.35** (.05)	13 (2.4)	34 (4.6)	21** (5.0)	.68** (.11)
Support of inquiry learning	61 (3.3)	61 (2.7)	0 (3.3)	.45** (.11)	35 (1.8)	37 (1.6)	2 (2.0)	.63** (.04)	36 (3.3)	52 (3.1)	16** (4.2)	.36** (.09)

*Note: 18 = percentage of teachers who reported using ICT for the teaching practice in 2018; 20 = percentage of teachers who reported using ICT for the teaching practice in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

for general school-related activities at least once a week or every day. There was no consistent pattern of changes in principals' use of ICT for general school-related activities between 2018 and 2020 across the three countries. In Denmark, we observed a significant decrease in percentage of principals' using ICT at least once a week or daily for the activities, ***provide information about an educational issue through a website*** and for ***preparing the curriculum***. The percentage of principals who used ICT for these activities at least once a week or daily dropped in 2020 compared to 2018 by 19 percentage points and 14 percentage points, respectively. In Finland, no significant changes were observed for any activities between 2018 and 2020. In Uruguay, principals' use of ICT changed significantly for two activities, ***maintaining, organizing and analyzing data*** and ***using social media to communicate with the wider community about school-related activities***. The percentage of principals who used ICT at least once a week or daily, increased by 11 percentage points and 31 percentage points between 2018 and 2020 for these two activities, respectively.

ICILS continued to gather school principals' use of ICT for school-related communication activities with a further four statements. The results are presented in Table 3.15 are percentages of principals who reported using ICT for school-related communication activities at least once a week or every day. There were no significant changes between 2018 and 2020 in Denmark and Uruguay, but one in Finland. The principals in Finland reported that they are using ICT most frequently for ***communication with teachers in their school***. In Finland, we observed a significant increase in the use of ICT at least once a week or daily for ***communication with parents***. An increase of about 8 percentage points is observed in the principals'

Table 3.14: Percentages of principals who reported using ICT for general school-related activities at least once a week but not every day, or everyday

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Search for information on the internet or school network	100 (-)	100 (-)	0 (-)	-	95 (2.0)	95 (1.7)	1 (2.6)	.27 (.23)	95 (2.9)	100 (-)	5 (2.9)	-
Provide info. about an educational issue through a website	77 (4.6)	58 (6.8)	-19* (8.7)	.02 (.19)	53 (4.6)	55 (4.0)	2 (5.3)	.24 (.14)	76 (7.2)	82 (6.2)	5 (8.1)	.42 (.27)
Look up records in a database (e.g., in a student information system)	94 (2.4)	92 (3.3)	-3 (4.1)	-	96 (1.9)	98 (1.1)	2 (1.8)	.82** (.21)	85 (10.0)	97 (2.5)	12 (10.6)	-
Maintain, organize and analyze data (e.g., with a spreadsheet)	79 (4.6)	79 (5.8)	-1 (5.3)	.35 (.19)	61 (4.0)	59 (4.2)	-2 (5.3)	.36** (.12)	68 (9.3)	79 (9.5)	11* (4.3)	.91** (.10)
Prepare presentations	49 (5.4)	52 (5.7)	3 (8.0)	.20 (.19)	60 (4.2)	67 (4.2)	7 (4.6)	.34** (.12)	52 (10.0)	37 (7.8)	-15 (12.9)	.29 (.28)
Work with a learning management system (e.g., [Moodle])	34 (7.1)	37 (6.7)	3 (10.3)	-.02 (.18)	38 (4.5)	43 (4.8)	5 (5.5)	.42** (.13)	45 (9.3)	73 (9.7)	28 (17.0)	-.29 (.43)
Use social media to communicate about school-related activities	32 (6.6)	26 (6.0)	-7 (6.5)	.70** (.11)	31 (4.2)	30 (3.5)	-1 (5.3)	.24 (.15)	48 (10.0)	79 (7.1)	31** (10.6)	.56* (.24)
Management of staff (e.g., scheduling, prof. development)	89 (3.6)	87 (4.4)	-2 (5.5)	.11 (.26)	66 (4.1)	71 (3.9)	5 (5.4)	.12 (.17)	66 (6.8)	74 (7.5)	8 (10.4)	.46 (.29)
Preparing the curriculum	22 (6.3)	8 (4.3)	-14* (6.3)	.52* (.23)	14 (3.4)	14 (3.1)	0 (4.4)	.32 (.19)	42 (9.6)	52 (8.2)	9 (9.0)	.45 (.26)
School financial management	64 (6.6)	69 (5.8)	4 (8.0)	.30* (.15)	69 (3.8)	74 (3.4)	6 (4.4)	.47** (.12)	29 (8.7)	45 (10.1)	15 (12.2)	.44* (.22)

*Note: 18 = percentages of principals who reported using ICT for the school-related activity in 2018; 20 = percentage of principals who reported using ICT for the school-related activity in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

answers on using ICT at least once a week or daily in 2020 compared to 2018. The correlation coefficients are significant and positive for most or all statements across the countries.

3.3.2 School principals' responses to ICT-related education outcomes

The ICILS principal questionnaire asked school principals about the importance of a set of education-related outcomes associated with the use of ICT in their school. Principals were asked to rate outcomes as "very important," "quite important," "somewhat important," or "not important".

The results are presented in Table 3.16 as percentages of principals who reported ICT-related outcomes of education as quite important or very important. There were a few significant changes, but no consistent changes across the countries between 2018 and 2020. In Denmark, the only significant change was observed regarding the importance of ***using ICT to augment and improve students learning***. An increase of about 7 percentage points was observed for principals that regarded this as quite important or very important in 2020 compared to 2018. In Finland, no significant changes were observed. In Uruguay, an increase in the perceived importance of ***development of students' ability to write apps or programs*** was observed. Almost one third more principals rated this as quite important or important in 2020 compared to 2018.

Table 3.15: Percentages of principals who reported using ICT for school-related communication activities at least once a week but not every day, or everyday

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Communicate with teachers in your school	100 (-)	100 (-)	0 (-)	-	98 (1.4)	100 (-)	2 (1.4)	-	94 (3.3)	96 (2.6)	2 (3.9)	.36 (1.39)
Communicate with education authorities	69 (6.8)	63 (6.6)	-6 (6.2)	.76** (.12)	79 (3.8)	83 (3.2)	4 (4.2)	.55** (.13)	70 (10.9)	71 (11.1)	1 (9.6)	.71* (.29)
Communicate with principals and senior staff in other schools	67 (5.7)	62 (5.7)	-5 (7.8)	.43* (.17)	77 (3.4)	80 (3.6)	3 (4.9)	.41* (.18)	62 (8.8)	61 (10.5)	-1 (10.4)	.58* (.28)
Communicate with parents	95 (2.5)	95 (2.5)	0 (3.3)	.45 (.25)	81 (3.8)	89 (3.1)	8* (3.8)	.67** (.15)	39 (8.9)	58 (8.7)	19 (11.2)	.53 (.35)

*Note: 18 = percentage of principals who reported using ICT for the school-related communication activity in 2018; 20 = percentage of principals who reported using ICT for the school-related communication activity in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Table 3.16: Percentages of principals who viewed ICT-related outcomes of education as quite important or very important

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Develop students' basic computer skills (e.g., internet use, email, etc.)	95 (3.1)	96 (2.9)	0 (1.7)	.90 (1.90)	94 (2.3)	94 (2.2)	0 (2.0)	.80** (.12)	86 (6.4)	95 (2.6)	8 (6.5)	.02 (.28)
Develop students' skills in using ICT for collaboration with others	92 (4.3)	97 (2.7)	6 (3.4)	-	91 (2.6)	94 (2.3)	2 (3.4)	.31 (.21)	84 (7.1)	93 (4.0)	9 (6.1)	.72* (.31)
Use ICT for facilitating students' responsibility for their learning	83 (6.3)	88 (4.8)	4 (5.7)	.56 (.32)	90 (2.8)	91 (2.8)	0 (3.6)	.31 (.22)	82 (7.3)	95 (3.7)	13 (6.6)	.67 (.45)
Use ICT to augment and improve students' learning	89 (3.2)	97 (2.9)	7** (1.6)	.80 (1.82)	96 (1.7)	92 (2.5)	-4 (3.3)	.22 (.22)	90 (5.8)	98 (1.8)	8 (5.8)	.38 (.30)
Develop students' skills relating to safe and appropriate use of ICT	95 (3.2)	93 (4.2)	-2 (3.7)	.76 (1.76)	99 (0.9)	97 (1.8)	-2 (1.8)	.74** (.18)	87 (6.3)	96 (2.1)	9 (5.8)	.65** (.22)
Develop students' proficiency in accessing and using info. with ICT	96 (3.1)	97 (2.8)	1 (1.5)	.95 (1.95)	99 (0.9)	96 (2.0)	-3 (2.0)	.66** (.19)	89 (5.9)	95 (3.5)	6 (6.7)	.11 (.41)
Develop students' ability to write [apps] or programs	31 (6.8)	24 (6.0)	-7 (7.5)	.41* (.20)	56 (4.2)	58 (4.7)	1 (5.4)	.36** (.14)	46 (10.5)	75 (7.8)	29* (12.9)	.26 (.31)

*Note: 18 = percentage of principals who reported the ICT-related outcome as important in 2018; 20 = percentage of principals who reported the ICT-related outcome as important in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

3.3.3 School principals' responses on expected ICT knowledge and skills of teachers

School principals were asked whether teachers in their school were expected to acquire knowledge and skills in a range of different activities related to ICT. Eight items asked principals' expectations of ICT use by

teachers, and the remaining three items asked principals' expectations for teacher collaboration using ICT. For each activity, they were asked to select either "expected and required," "expected but not required," or "not expected."

The results are presented in Table 3.17 as percentages of principals who reported that teachers were expected and required to undertake a range of ICT-based activities. For the most part, no significant changes were observed between 2018 and 2020. In Denmark, significant increases were only observed regarding two activities: ***using ICT-based forms of student assessment*** (24 percentage points increase) and ***assessing students' computer and information literacy*** (14 percentage points increase). In Finland, the percentage of principals reporting expectations that teachers' ***assess students' computer and information literacy*** increased by 10 percentage points. No significant changes were observed in Uruguay between 2018 and 2020.

Table 3.17: Percentages of principals who reported teachers are expected and required to use ICT

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Integrate web-based learning in their instructional practice	77 (6.0)	72 (6.7)	-6 (8.4)	.36 (.22)	21 (4.0)	36 (4.1)	15** (5.5)	.23 (.17)	24 (10.1)	25 (8.9)	0 (11.6)	.45 (.35)
Use ICT-based forms of student assessment	52 (7.6)	76 (6.7)	24** (6.7)	.69** (.13)	52 (5.0)	42 (4.8)	-10 (6.0)	.53** (.11)	18 (6.2)	25 (8.6)	7 (9.6)	.04 (.29)
Use ICT for monitoring student progress	66 (7.6)	57 (7.5)	-9 (9.0)	.59** (.16)	47 (3.8)	43 (4.9)	-4 (6.2)	.15 (.16)	14 (4.3)	27 (9.3)	13 (9.5)	-.15 (.31)
Integrate ICT into teaching and learning	97 (2.7)	88 (5.2)	-9 (5.9)	-	72 (3.8)	77 (3.4)	5 (4.6)	.12 (.16)	33 (10.8)	41 (11.3)	7 (8.7)	.68** (.21)
Use subject-specific digital learning resources (e.g. tutorial, simulation)	46 (6.9)	50 (7.6)	4 (8.7)	.44* (.20)	48 (4.6)	47 (4.3)	-1 (6.2)	.47** (.12)	17 (8.9)	20 (8.1)	3 (12.5)	-.04 (.41)
Use e-portfolios for assessment	28 (5.4)	21 (4.2)	-8 (5.5)	.50** (.18)	11 (3.2)	12 (3.0)	0 (4.4)	.51** (.17)	9 (3.9)	18 (6.6)	9 (6.4)	.58** (.23)
Use ICT to develop authentic (real-life) assignments for students	16 (5.0)	20 (6.0)	4 (8.4)	.07 (.25)	13 (3.0)	7 (2.0)	-6 (3.4)	.15 (.25)	16 (9.7)	13 (6.1)	-3 (12.2)	-
Assess students' [computer and information literacy]	13 (3.7)	27 (5.8)	14* (5.6)	.44* (.19)	35 (4.8)	45 (4.3)	10* (5.0)	.42** (.11)	12 (8.7)	9 (4.1)	-3 (10.1)	-.03 (.45)

*Note: 18 = percentage of principals who reported teachers are expected and required to use ICT in 2018; 20 = percentage of principals who reported teachers are expected and required to use ICT in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Principals were also asked to report their expectations for teachers to use ICT for collaboration with other teachers, parents and students. These results are presented in Table 3.18 as percentages of principals who report that teachers are expected and required to use ICT for collaboration. In Denmark, no significant changes were observed between 2018 and 2020. In both Finland and Uruguay, there was a significant increase in the percentage of principals reporting that they expected and required teachers to ***communicate with students via ICT*** (11 percentage points in Finland and 27 percentage points in Uruguay).

3.3.4 School principals' responses on their priorities for facilitating ICT use at schools

School principals were asked to report on the priority they gave to different statements related to facilitating ICT use in teaching and learning in their schools. Two categories for facilitating ICT use were presented to principals: Priorities relating to providing infrastructure support and priorities relating to the provision of

Table 3.18: Percentages of principals who reported teachers are expected and required to use ICT for collaboration

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Collaborate with other teachers via ICT	74 (5.9)	68 (7.4)	-6 (7.7)	.51* (.21)	67 (4.2)	66 (3.7)	-1 (4.9)	.27 (.15)	11 (4.7)	20 (9.0)	9 (10.1)	.23 (.33)
Communicate with parents via ICT	98 (2.2)	98 (1.2)	0 (2.5)	-	94 (2.5)	91 (2.8)	-3 (3.8)	.03 (.23)	7 (3.9)	14 (6.5)	8 (7.5)	-
Communicate with students via ICT	90 (4.3)	89 (4.8)	-1 (5.0)	.53* (.24)	74 (3.9)	86 (3.1)	11* (5.0)	.18 (.21)	4 (3.0)	31 (9.4)	27** (9.0)	.50* (.24)

*Note: 18 = percentage of principals who reported teachers are expected and required to use ICT in 2018; 20 = percentage of principals who reported teachers are expected and required to use ICT in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

general resources and pedagogical support. Principals were asked to select one of the following response options: "high priority," "medium priority," "low priority," or "not a priority" for each way of facilitating ICT use in the school.

The first three statements in the question asked principals' to report on their priorities for facilitating the use of ICT resources related to the provision of ICT infrastructure. The results are presented in Table 3.19 as percentages of principals who reported a moderate or high priority for each statement. In Denmark and Finland, between 2018 and 2020 a significant decrease was observed in the percentage of principals reporting on ***increasing bandwidth of Internet access for computers*** as a moderate or high priority. These percentages decreased by 16 percentage points in Denmark and by 14 percentage points in Finland. In Uruguay, the only significant change that was observed was an increase of 6 percentage points for principals reporting that ***increasing numbers of school computers per student*** was of moderate or high priority in facilitating the use of ICT in teaching.

Table 3.19: Percentages of principals who reported giving a moderate or high priority to providing infrastructure support to facilitate teaching and learning

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Increase the number of computers per student in the school	64 (7.4)	63 (7.2)	-1 (8.0)	.71** (.13)	94 (2.1)	95 (1.9)	0 (2.4)	.52* (.22)	90 (4.8)	96 (3.7)	6* (3.0)	-
Increase the number of computers connected to the Internet	55 (6.6)	61 (7.3)	7 (10.2)	.20 (.22)	90 (3.0)	87 (2.9)	-3 (3.9)	.34 (.20)	94 (4.1)	96 (3.7)	2 (1.7)	-
Increase the bandwidth of Internet access for computers	82 (5.2)	66 (7.6)	-16* (6.9)	.50* (.19)	93 (2.2)	79 (3.7)	-14** (3.9)	.52** (.19)	88 (7.6)	93 (3.9)	5 (7.0)	.59 (1.60)

*Note: 18 = percentage of principals who reported prioritizing the provision of infrastructure support to facilitate teaching and learning in 2018; 20 = percentage of principals who reported prioritizing the provision of infrastructure support to facilitate teaching and learning in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

Seven statements in this section of the principals' questionnaire, addressed principals' priority level for a range of general resources and pedagogical support to facilitate the use of ICT in teaching and learning. The results are presented in Table 3.20 as percentages of principals that reported a moderate or high priority for each of the seven statements. No significant change is observed in Denmark and Uruguay. In Finland, the only significant decrease occurred in principals' answers regarding the priority given to ***increasing the professional learning resources***. This was given a moderate or high priority by about 12 percentage points, which is fewer principals giving priority to this statement in 2020 compared to 2018. In general, the decrease or no change in priority could be due to the fact that resources are already available in more of the schools.

Table 3.20: Percentages of principals who reported giving a moderate or high priority to providing general ICT resources and pedagogical support

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Increase the range of digital learning resources available	90 (3.7)	81 (6.2)	-8 (5.7)	.62** (.24)	96 (1.8)	93 (2.3)	-3 (2.6)	.67** (.16)	95 (4.2)	95 (4.2)	0 (2.5)	.92 (1.92)
Establish or enhance an online learning support platform	75 (5.6)	77 (6.4)	2 (8.3)	-.11 (.26)	82 (3.7)	82 (3.6)	0 (4.5)	.41* (.18)	83 (7.8)	91 (4.2)	7 (8.8)	.23 (.41)
Support participation in prof. dev. on pedagogical use of ICT	79 (6.3)	81 (5.5)	2 (8.0)	.14 (.26)	99 (0.6)	97 (1.5)	-3* (1.3)	-	98 (1.9)	100 (-)	2 (1.9)	-
Increase availability of qualified tech. personnel to support ICT use	78 (6.0)	76 (5.5)	-2 (6.5)	.55** (.18)	89 (3.1)	82 (3.7)	-7 (4.6)	.16 (.18)	88 (6.6)	68 (13.0)	-21 (14.0)	.60 (.36)
Provide teachers with incentives to integrate ICT use in their teaching	88 (5.4)	82 (5.4)	-6 (6.2)	.54* (.25)	60 (5.3)	61 (4.4)	1 (6.1)	.37** (.14)	83 (8.3)	69 (12.6)	-13 (12.8)	.72** (.23)
Provide more time for teachers to prepare lessons where ICT is used	37 (7.3)	39 (7.4)	2 (8.3)	.36 (.23)	64 (4.8)	57 (4.7)	-7 (6.1)	.31* (.14)	66 (12.7)	60 (12.4)	-6 (7.6)	.85** (.13)
Increase prof. learning resources for teachers in the use of ICT	72 (6.5)	70 (5.8)	-2 (6.6)	.55** (.19)	97 (1.5)	86 (3.1)	-12** (3.3)	.14 (.24)	96 (3.7)	85 (8.0)	-11 (7.3)	-

*Note: 18 = percentage of principals who prioritized the provision of the ICT resources and pedagogical support in 2018; 20 = percentage of principals who prioritized the provision of the ICT resources and pedagogical support in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

3.4 School ICT coordinator survey

In this section, we use the data collected from the ICT coordinators. In ICILS, schools were asked to name an ICT coordinator, this could be either a formal or informal position, or be another specifically nominated staff member with knowledge about ICT-related issues at school. The ICT coordinators provided information about ICT resources, and technical and pedagogical support for ICT use for teaching and learning at school. In this study, we focus on ICT coordinators' views of schools' access to ICT resources and the hindrances to the use of ICT for teaching and learning at school.

3.4.1 Schools' access to ICT resources

School ICT coordinators were asked to identify whether a variety of several specific technology and software resources were available in their school, and whether these resources were available to "only students," "only teachers," or "both students and teachers". The availability of ICT resources in schools are grouped by access to technology-based resources, access to software resources, and access to technology facilities.

Table 3.21 summarizes the percentages of ICT coordinators who indicated that both students and teachers have access to technology-based resources. In Denmark, no significant change was observed. In Finland, there was a significant increase (11 percentage points) between 2018 and 2020, in the proportion of ICT coordinators reporting that both teachers and students could have access to ***email accounts for school related use*** and a significant but small decrease (4 percentage points) in the proportion of ICT coordinators reporting that both students and teachers have ***access to the Internet through the school network***. It should, however, be noted that this percentage remained very high (96%) in 2020. In Uruguay, there was also a significant increase (20 percentage points) in the proportion of ICT coordinators reporting that ***email accounts for school-related use*** were available for teachers and students.

Table 3.21: Percentages of ICT coordinators who indicated that technology-based resources are available for both teachers and students

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Digital learning resources that can be accessed offline	68 (7.0)	75 (7.1)	7 (9.3)	.18 (.30)	51 (4.5)	46 (4.7)	-5 (6.4)	.12 (.15)	70 (7.7)	71 (7.5)	1 (12.6)	.14 (.19)
Digital learning resources that can only be used online	100 (-)	99 (1.2)	-1 (1.2)	-	94 (2.0)	89 (2.9)	-5 (3.4)	.41* (.20)	86 (4.8)	75 (8.2)	-10 (8.4)	.50* (.22)
Access to the Internet through the school network	100 (-)	100 (-)	0 (-)	-	99 (0.7)	96 (1.5)	-4* (1.7)	-	82 (8.3)	92 (3.2)	10 (9.1)	-
Access to education site/network maintained by ed. authorities	89 (4.5)	79 (6.6)	-10 (7.5)	.14 (.30)	66 (4.3)	61 (4.9)	-4 (7.3)	-.11 (.14)	74 (7.3)	78 (8.0)	4 (8.4)	.72** (.22)
Email accounts for school-related use	85 (6.3)	87 (6.6)	2 (7.1)	.61* (.25)	85 (3.1)	96 (2.2)	11** (3.1)	.73* (.36)	35 (7.3)	55 (8.8)	20* (9.3)	.30 (.22)

*Note: 18 = percentage of ICT coordinators who indicated that the resource is available in 2018; 20 = percentage of ICT coordinators who indicated that the resource is available in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

School ICT coordinators were also asked to identify whether a range of software resources are available in their school, and whether these were available to only students, only teachers, or both students and teachers. Table 3.22 summarizes the percentages of ICT coordinators who indicated that both students and teachers have access to the software resources.

For the most part, the availability of different software resources did not change significantly across the countries between 2018 and 2020. Two resources, ***graphing or drawing software*** and ***social media***, showed significant changes in both Denmark and Finland between 2018 and 2020. While in Denmark, an increase of about 15 percentage points was recorded for ICT coordinators reporting that teachers and students had access to ***graphing or drawing software*** in 2020 compared to 2018, in Finland, this decreased in 2020 by 11 percentage points compared to 2018. The availability of ***social media*** to teachers and students according to ICT coordinators significantly decreased in both countries between 2018 and 2020, by 18 percentage points in Denmark and by 17 percentage points in Finland. In Denmark, a significant increase (14 percentage points) of availability of ***digital contents linked with textbooks*** for teachers and students was observed. In Uruguay, there were two resources for which the availability changed significantly, for both teacher and students between 2018 and 2020, according to the ICT coordinators that participated. These were access to for ***e-portfolios*** (an increase of 18 percentage points) and ***a learning management system*** (an increase of 12 percentage points in 2020 reported by 100% of the ICT coordinators).

ICT coordinators were also asked about the technology facilities available in their school for the teaching and learning of the target grade students. Again, they were asked to indicate whether each facility was

Table 3.22: Percentages of ICT coordinators who indicated that software-related resources are available for both teachers and students

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Practice program where teachers decide which questions are asked	100 (-)	96 (3.5)	-4 (3.5)	-	89 (2.9)	94 (2.3)	4 (3.5)	.22 (1.23)	82 (7.8)	92 (4.6)	10 (11.2)	-
Single user digital learning games (e.g., [languages online])	75 (6.7)	72 (7.6)	-3 (10.9)	-.15 (.27)	78 (3.8)	79 (3.5)	0 (5.0)	.30* (.15)	60 (7.8)	61 (6.5)	1 (6.9)	.30 (.24)
Multi-user digital learning games with graphics and inquiry tasks	30 (6.9)	39 (7.3)	9 (8.3)	.37 (.20)	52 (4.5)	62 (3.8)	11 (5.5)	.44** (.12)	28 (7.0)	38 (6.1)	10 (8.0)	.07 (.26)
Word-processing software (e.g., [Microsoft Word®])	99 (0.8)	100 (-)	1 (0.8)	-	99 (0.6)	98 (1.2)	-1 (1.3)	-	89 (6.8)	94 (5.0)	6 (8.8)	-
Presentation software (e.g., [Microsoft PowerPoint®])	99 (0.8)	100 (-)	1 (0.8)	-	99 (0.6)	98 (1.2)	-1 (1.3)	-	89 (6.9)	94 (5.1)	6 (9.0)	-
Video and photo software for capture and editing	89 (5.7)	91 (5.9)	1 (8.9)	-	96 (1.6)	94 (2.1)	-3 (2.3)	.42 (1.42)	86 (7.1)	84 (7.7)	-3 (6.1)	.78** (.17)
Concept mapping software (e.g., [Inspiration®], [Webspiration®])	74 (7.7)	76 (7.7)	2 (10.6)	.13 (.31)	72 (4.2)	68 (4.4)	-5 (5.5)	.51** (.12)	62 (8.0)	68 (9.2)	6 (9.1)	.44 (.24)
Data logging and monitoring tools that capture data for analysis	46 (7.7)	53 (7.9)	7 (9.4)	.47* (.21)	20 (3.8)	25 (3.7)	5 (5.2)	.34* (.15)	26 (5.3)	22 (6.0)	-4 (6.3)	.67** (.18)
Simulations and modelling software (e.g., [NetLogo])	37 (7.2)	51 (7.8)	15 (10.5)	.10 (.23)	84 (3.1)	83 (3.5)	-1 (3.9)	.50** (.18)	31 (6.0)	25 (7.0)	-6 (6.0)	.56** (.20)
A learning management system (e.g., [Edmodo], [Blackboard])	81 (6.4)	85 (6.8)	4 (8.5)	.40 (.44)	97 (1.8)	98 (1.3)	1 (2.2)	-	88 (4.9)	100 (-)	12* (4.9)	-
Graphing or drawing software	64 (7.9)	79 (6.6)	15* (7.8)	.55** (.21)	97 (1.3)	86 (2.8)	-11** (3.1)	.18 (.22)	89 (3.4)	90 (5.6)	1 (7.5)	-
e-portfolios (e.g., [VoiceThread])	26 (5.8)	36 (7.2)	11 (8.4)	.26 (.21)	78 (4.3)	73 (4.0)	-5 (5.4)	.26 (.15)	80 (7.5)	98 (1.8)	18* (7.3)	-
Digital contents linked with textbooks	79 (6.8)	92 (3.6)	14* (7.0)	.43 (.37)	88 (3.2)	89 (3.0)	1 (4.2)	.14 (.20)	73 (8.6)	80 (7.8)	7 (8.1)	.56* (.26)
Social media (e.g., [Facebook, Twitter])	84 (5.4)	66 (7.2)	-18* (8.0)	.55* (.22)	72 (3.6)	55 (4.2)	-17** (5.3)	.30* (.14)	67 (9.7)	80 (7.9)	14 (12.2)	.12 (.26)

*Note: 18 = percentage of ICT coordinators who indicated that the ICT software resource is available to both teachers and students in 2018; 20 = percentage of ICT coordinators who indicated that the ICT software resource is available to both teachers and students in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

available either only for students, only for teachers, or for both groups. The Table 3.23 summarizes the percentages of ICT coordinators who indicated that both students and teachers had access to the facilities.

In Denmark, the only significant change in the responses was observed for ***space on school network to store files***. An increase of about 24 percentage points was observed for ICT coordinators reporting that this technology is available for both students and teachers in 2020 compared to 2018. In Finland, significant increases were observed in three technology resources: ***remote access to a school network***, ***a 3D***

Table 3.23: Percentages of ICT coordinators who indicated that technology facilities are available for both teaching and learning

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Remote access to a school network	43 (7.8)	42 (7.7)	-1 (8.5)	.41 (.21)	16 (2.9)	30 (4.1)	14** (4.7)	.15 (.16)	63 (7.9)	65 (7.4)	2 (7.1)	.80** (.12)
Space on a school network to store files	61 (7.8)	85 (5.2)	24** (8.4)	.33 (.29)	77 (4.1)	62 (4.4)	-15** (5.3)	.40** (.14)	41 (7.6)	39 (8.2)	-2 (9.9)	.35 (.23)
A school intranet with applications and workplaces	81 (5.9)	63 (7.6)	-18 (10.6)	-.12 (.26)	37 (4.2)	30 (4.5)	-7 (5.9)	.25 (.16)	29 (6.9)	25 (6.9)	-5 (5.8)	.59** (.17)
Internet-based applications for collaborative work	99 (0.8)	100 (-)	1 (0.8)	-	95 (2.2)	95 (2.0)	0 (3.2)	-	58 (8.7)	91 (3.7)	33** (10.3)	-
A 3D printer	30 (6.7)	43 (7.8)	13 (7.3)	.62** (.15)	32 (3.4)	50 (4.1)	18** (4.2)	.69** (.07)	21 (7.1)	17 (5.1)	-4 (7.1)	.82** (.15)
Robots or robotic devices	59 (7.7)	68 (7.3)	9 (8.5)	.50* (.21)	56 (4.5)	68 (4.6)	12** (4.6)	.71** (.08)	71 (5.9)	63 (8.1)	-7 (8.7)	.71** (.17)
Access to a wireless LAN (wifi)	100 (-)	100 (-)	0 (-)	-	91 (2.6)	93 (2.4)	2 (2.4)	.87** (.09)	76 (8.8)	90 (4.6)	14 (8.8)	.16 (1.17)
A learning management system (e.g., [WebCT®], [Moodle])	77 (6.7)	88 (5.6)	11 (6.5)	.71** (.24)	96 (1.9)	99 (0.9)	3 (1.7)	-	82 (8.1)	100 (-)	18* (8.1)	-

*Note: 18 = percentage of ICT coordinators who indicated that the technology facility is available for both teaching and learning in 2018; 20 = percentage of ICT coordinators who indicated that the technology facility is available for both teaching and learning in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

printer and ***robots or robotic devices***. These increases were 14 percentage points, 18 percentage points and 12 percentage points, respectively. The proportion of ICT coordinators reporting that students and teachers had access to ***space on a school network to store their work*** decreased in Finland by 15 percentage points between 2018 and 2020. There were two significant changes observed in Uruguay: the proportion of ICT coordinators reporting access to ***internet-based application for collaborative work*** increased by 33 percentage points, and access to ***a learning management system*** increased by 18 percentage points. The last increase is consistent with the teacher responses.

3.4.2 Hindrances to the use of ICT for teaching and learning at school

In the questionnaire, school ICT coordinators were asked about the extent to which they perceived that the use of ICT for teaching was hindered by different resource-related obstacles. For each of the 14 obstacles, they could rate their impact as "a lot," "to some extent," "very little," or "not at all". The hindrances are grouped into computer resources and pedagogical hindrances.

The first six obstacles in the question are related to the lack of computer resources at school. Table 3.24 shows the percentages of ICT coordinators that reported the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient computer resources.

Although the differences between 2018 and 2020 vary across countries, there is a general pattern in the data that there was a decrease in the percentage of reported hindrances between 2018 and 2020. In Denmark and Uruguay, there were significant decreases in the percentage of ICT coordinators that reported that there were ***too few computers connected to the Internet***, 7 percentage points and 22 per-

Table 3.24: Percentages of ICT coordinators who reported that the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient computer resources

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Too few computers connected to the Internet	7 (3.4)	0 (-)	-7* (3.4)	-	11 (2.5)	12 (3.1)	2 (3.3)	.45* (.21)	34 (7.2)	12 (4.6)	-22** (8.2)	.51* (.26)
Insufficient Internet bandwidth or speed	11 (4.7)	3 (2.0)	-8 (5.1)	-	35 (4.3)	31 (4.1)	-4 (4.1)	.61** (.11)	52 (7.6)	44 (6.5)	-8 (7.7)	.60** (.18)
Not enough computers for instruction	17 (5.2)	9 (3.9)	-8 (5.7)	.44 (.26)	64 (4.1)	52 (4.2)	-13* (5.3)	.22 (.15)	45 (7.5)	47 (9.1)	2 (8.1)	.57** (.17)
Lack of sufficiently powerful computers	30 (7.6)	17 (5.7)	-13 (9.7)	.06 (.31)	51 (4.9)	33 (4.4)	-18** (5.8)	.24 (.14)	68 (6.2)	55 (7.4)	-12* (5.9)	.73** (.13)
Problems in maintaining ICT equipment	28 (6.8)	15 (4.9)	-13* (6.5)	.65** (.18)	51 (4.9)	54 (4.3)	4 (6.1)	.18 (.13)	47 (8.1)	27 (6.5)	-20** (7.4)	.83** (.10)
Not enough computer software	9 (4.0)	12 (6.4)	3 (8.0)	-	39 (4.4)	32 (3.6)	-8 (4.8)	.29* (.14)	32 (6.8)	23 (6.6)	-9 (8.1)	.46* (.21)

*Note: 18 = percentage of ICT coordinators who reported that the use of ICT was hindered by the insufficient computer resource in 2018; 20 = percentage of ICT coordinators who reported that the use of ICT was hindered by the insufficient computer resource in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *p< .05, **p< .01.*

centage points, respectively, and in ***problems in maintaining ICT equipment***, 13 percentage points and 20 percentage points, respectively. In Denmark, in 2020, 0% of ICT coordinators reported that having ***too few computers connected to the Internet*** was a hindrance. In Finland and Uruguay, there were significant decreases in the proportion of ICT coordinators reporting that there was a ***lack of sufficiently powerful computers***, 18 percentage points and 12 percentage points, respectively. In Finland, the proportion of ICT coordinators reporting that there were ***not enough computers for instruction*** decreased by 13 percentage points between 2018 and 2020.

The remaining eight statements in the question related to ICT coordinators' perceptions of the degree to which the lack of specific pedagogical resources at school were hindrances to the use of ICT in teaching and learning. Table 3.25 shows the percentages of ICT coordinators that reported the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient pedagogical resources.

No consistent significant change was observed across countries. In Denmark, the only significant change was observed for ***insufficient time for teachers to prepare lessons***. This was perceived as a hindrance to a lesser extent (a decrease of 18 percentage points) in 2020 compared to 2018. In Finland, significant changes were observed for four statements: ***insufficient ICT skills among teachers***, ***lack of effective professional learning resources for teachers***, ***lack of an effective online learning support platform*** and ***lack of incentives for teachers to integrate ICT in teaching***. All of these were reported by significantly fewer ICT coordinators as perceived hindrances to teaching and learning in 2020 compared to 2018. The decreases ranged between 9 percentage points and 14 percentage points. In Uruguay, a significant change was observed for ***lack of an effective online learning support platform*** and ***restricted access to useful Internet resources***. In both statements, a significant decrease in the perceived hindrances was reported by the ICT coordinators. The observed decreases were 25 percentage points and 16 percentage points, respectively.

Table 3.25: Percentages of ICT coordinators who reported that the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient pedagogical resources

Item	Denmark				Finland				Uruguay			
	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}	18	20	Δ	r_{tet}
Insufficient ICT skills among teachers	49 (7.8)	55 (8.0)	6 (7.2)	.66** (.15)	86 (2.8)	77 (4.0)	-9* (4.4)	.44* (.18)	60 (8.5)	62 (7.8)	2 (8.7)	.47* (.19)
Insufficient time for teachers to prepare lessons	66 (8.1)	47 (7.8)	-18* (8.9)	.46* (.23)	74 (3.5)	73 (3.9)	0 (5.3)	.23 (.15)	52 (8.3)	59 (8.4)	7 (8.7)	.40* (.19)
Lack of effective professional learning resources for teachers	33 (7.9)	18 (4.8)	-15 (9.4)	.14 (.27)	73 (4.3)	58 (4.6)	-14* (6.1)	.11 (.17)	60 (7.2)	56 (9.5)	-4 (7.4)	.43 (.23)
Lack of an effective online learning support platform	33 (7.7)	16 (4.8)	-17 (9.7)	-.31 (.23)	37 (4.5)	26 (4.4)	-12* (5.8)	.26 (.14)	54 (6.3)	29 (8.3)	-25** (8.6)	.79** (.13)
Lack of incentives for teachers to integrate ICT in teaching	38 (7.9)	30 (7.0)	-7 (11.6)	-.10 (.24)	75 (4.3)	63 (4.2)	-12* (5.7)	.40** (.13)	55 (9.7)	50 (6.4)	-5 (12.5)	-.01 (.30)
Restricted access to useful Internet resources	10 (5.7)	5 (4.2)	-5 (7.4)	-	11 (2.7)	11 (2.8)	0 (3.3)	.53** (.18)	26 (7.3)	9 (3.1)	-16* (8.1)	.02 (.25)
Insufficient technical ICT support	23 (6.9)	20 (6.9)	-4 (7.8)	.32 (.28)	43 (4.6)	48 (4.4)	5 (6.7)	.00 (.12)	36 (8.5)	35 (8.6)	-2 (9.2)	.52* (.23)
Insufficient pedagogical support for the use of ICT	35 (7.5)	28 (7.2)	-7 (7.9)	.52* (.21)	58 (5.1)	56 (3.9)	-2 (6.2)	.22 (.13)	56 (9.6)	41 (8.8)	-14 (8.7)	.60** (.18)

*Note: 18 = percentage of ICT coordinators who reported that the use of ICT for teaching and learning was hindered by the insufficient pedagogical resource in 2018; 20 = percentage of ICT coordinators who reported that the use of ICT for teaching and learning was hindered by the insufficient pedagogical resource in 2020; Δ = differences 2020 minus 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); r_{tet} = tetrachoric correlation between agreements in 2018 and 2020 (not provided when the minimum cell frequency is less than 5); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

3.5 Summary

The ICILS Teacher Panel collected data from teachers, principals, and ICT coordinators in 2020 to study how teaching, learning, ICT related topics, resources, behaviors and attitudes changed since ICILS 2018. Three countries participated in the ICILS Teacher Panel, Denmark, Finland and Uruguay. The data presented in this chapter can provide some useful information to examine changes before and after the global COVID-19 outbreak. Importantly, estimates derived from the Teacher Panel should not be attributed solely to the pandemic without extra information and assumptions, as this was not the only event which can have an effect on the target population of the study. For clarity and completeness, this report provides the reader with the national context in which data collection took place in 2020 (see Chapter 2).

A consistent finding of the ICILS Teacher Panel is the increase of availability of ICT resources for teaching. Teachers from Denmark, Finland, and Uruguay report an increase in up-to-date computer equipment in their school, good internet connectivity, sufficient opportunities to develop expertise in ICT and sufficient technical support to maintain ICT resources. In addition, the use of communication software increased, but also collaborative activities between teachers. Teachers are increasingly confident in collaborating with others using shared resources, reporting an increase in sharing their ICT-based resources with each other. The use of ICT at school when teaching, but also outside school for work-related purposes, increased across all the countries.

Another consistent finding of the ICILS Teacher Panel is the change in teachers' emphasis on learning CIL. For teachers from Denmark, Finland, and Uruguay, we observed an increase in emphasis on CIL-related skills in class. Especially, giving more emphasis on teaching students how to evaluate the credibility of

digital information, to understand consequences of publishing information, and also how to use computer software to create work products, share information, and to provide digital feedback on the work of others. No consistent increase was observed for emphasis on CT-related skills in class. However, an increase in teachers' reporting on students' use of ICT for different class activities was observed. Especially for using ICT to submit or share their work, for communication (e.g., to communicate with students in other schools on projects, explain and discuss ideas with other students) and to individualize learning (e.g., work individually on learning materials at their own pace, reflect on their learning experiences and plan a sequence of learning activities for themselves).

The ICILS Teacher Panel suggests that teachers' use of ICT for teaching practices changed in 2020. For teachers from Denmark, Finland, and Uruguay, an increase of ICT use for teaching, assessment, and support for collaboration among students and others was observed. In general, increases for all constructs were more frequent and larger in Uruguay, where ICT use was not used as often as in Denmark and Finland in 2018.

The principal and ICT coordinator samples were smaller and not as many significant changes were observed. The results vary across countries. No consistent increase of ICT use for principals was observed for general school-related activities. Principals' use of ICT to communicate with parents increased in Finland and Uruguay, but not in Denmark (it already was a common practice in 2018). Similarly, more principals in Finland and Uruguay, required teachers to use ICT to communicate with students in 2020; with the exception of Denmark, where this was required for the majority of teachers already in 2018. In addition, significantly more principals in Denmark and in Finland, expected and required teachers to assess students' CIL using ICT, but this was not the case in Uruguay. ICT coordinators in Finland and Uruguay, report an increase in email accounts for school-related use that were available for students and teachers. Finally, we observed a decrease in specific insufficient computer and pedagogical resources across all the countries.

CHAPTER 4

Changes in inequality of opportunity

Yuan-Ling Liaw, Mojca Rozman, Rolf Strietholt, Justin Wild & Julian Fraillon

4.1 Introduction

In this chapter, we address whether inequality in educational opportunity changed between 2018 and 2020. There are concerns that the COVID-19 pandemic has particularly affected socially disadvantaged children and that existing socioeconomic inequalities have intensified (Haeck & Lefebvre, 2020; Hanushek & Woessmann, 2020; United Nations, 2020). We investigate this issue with panel data of teacher perspectives on schools' ICT-resources and their use for teaching and learning.

Schools strive to ensure inclusive, quality education for all students. Socioeconomic status (SES) is considered one of the more important factors affecting students' educational outcomes. Students' socioeconomic background is often measured as a combination of direct or proxy measures of parental education, income, and occupation. Internationally, unequal access to education has been documented in numerous studies (Hansen & Strietholt, 2018; Rolfe, 2021; Schmidt et al., 2001), some of which also mention access to and the use of ICT (Azubuike et al., 2021; Sims et al., 2008; Sutherland-Smith et al., 2003; van de Werfhorst et al., 2020, August 18). Under the assumption that ICT-related issues such as ***resources at schools***, ***teachers' attitudes toward digital learning***, and ***teachers' use of computers for teaching and learning*** are important determinants of students' educational outcomes, we aim to study the potential change in the opportunity gap based on teachers' responses from the ICILS Teacher Panel study. Understanding and detecting different opportunities may help to identify areas of focus in efforts to reduce the relative disadvantage for students from lower socioeconomic backgrounds.

To study the opportunity gap, we first identified teachers' ***SES group*** by dichotomizing teachers from socioeconomically advantaged or disadvantaged schools. To define a socioeconomically advantaged school and a socioeconomically disadvantaged school, we used the ICILS 2018 variable ***national index of socioeconomic background***, which was derived from the following three indices at student level information: ***highest occupational status of parents***, ***highest educational level of parents*** and ***number of books at home*** (for details of this index, please see Fraillon et al. (2020a, p. 170)). For each country, the national index of socioeconomic background was standardized with a mean of 0 and standard deviation of 1. For the ICILS Teacher Panel, this index was aggregated at the school level, and the school IDs were used to match the aggregated index to the ICILS Teacher Panel database. The median value within each country was used to divide schools into those with a low and high average socioeconomic student body, thereby creating a dichotomous value from the aggregated national index of socioeconomic background.

In the next step we computed the opportunity gap, defined as the differences between teachers from high and low SES schools with a certain response, which is referred to as ***SES gap***. Positive SES gap means more opportunities for high SES schools, and negative gap indicates more opportunities for low SES schools. It is well documented that the learning outcomes of socioeconomically disadvantaged children lag behind those of socioeconomically advantaged children (Volante et al., 2019). Against this backdrop, we are more concerned when low SES schools provide fewer learning opportunities to its students. Furthermore, to examine if the difference between low and high SES schools changes over time, We calculated the change in the gaps between 2018 and 2020. This information is summarized in the figures and tables below.

As previously mentioned, negative change values indicate a shift in favor of low SES schools. However, there are multiple ways a negative change value can occur (e.g., more learning opportunities in low SES schools, reduced learning opportunities in high SES schools with opportunities remaining unchanged in low SES schools, etc.). For this reason, it is important to understand how change values are derived when interpreting them.

4.2 Teacher survey

In this section, we take a closer look at aspects of teachers' teaching with and about ICT in schools between teachers from socioeconomically advantaged and teachers from disadvantaged schools in 2018 and 2020. We focus on teachers' familiarity with ICT, their views regarding its use for teaching and learning, and teachers' perceptions of schools' ICT learning environments. Furthermore, we review the emphasis teachers place on developing CIL and CT and their actual use of ICT in lessons and lesson preparation.

4.2.1 Teachers' familiarity with and views of ICT

Teachers' experience with ICT use

Teachers were asked about their (approximate) years of experience ("never," "less than two years," "between two and five years," or "more than five years") using ICT for teaching purposes ***during lessons*** as well as when ***preparing lessons***. Figure 4.1 illustrates the percentages of teachers who reported that they never used ICT ***during lessons*** or when ***preparing lessons*** between teachers from high SES and low SES schools and study cycle. Table 4.1 shows the difference between the SES groups as the ***SES gap*** in the years 2018 and 2020, respectively, and the difference between the SES gaps in 2018 and 2020.

In Denmark and Finland, the SES gaps related to teachers' experience with ICT use, were very small. This was due to the fact that there was a very small (close to zero) percentage of teachers who reported that they never used ICT ***during lessons*** or for ***preparing lessons*** in both 2018 and 2020. In Uruguay, the SES gaps for using ICT ***during lessons*** and ***preparing lessons*** were larger in the year 2018 but reduced in 2020. Further, in Uruguay, the SES gaps for teachers who reported never using ICT ***during lessons*** were significant in both years. The SES gap reduced in 2020, but the difference between the SES gaps was not significant.

Figure 4.1: Percentages of teachers who reported that they have never used ICT during lessons and when preparing lessons by SES group and study cycle

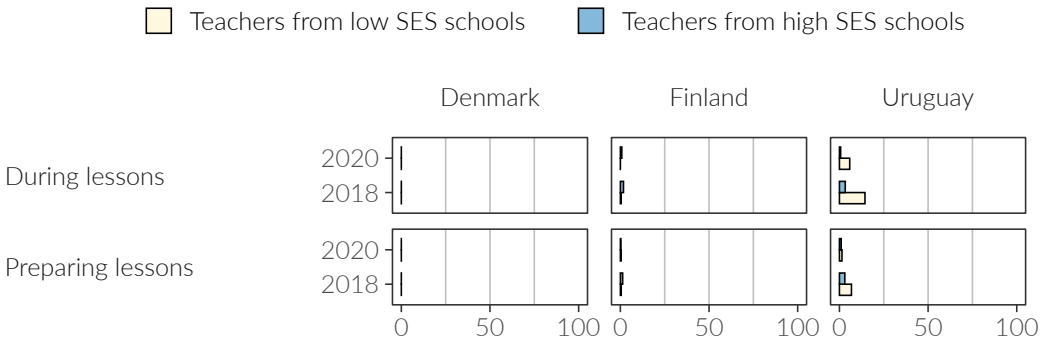


Table 4.1: Changes in SES gaps in the percentages of teachers who reported that they have never used ICT during lessons and when preparing lessons

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
During lessons	0 (0.0)	0 (0.0)	0 (0.0)	1* (0.7)	1 (0.4)	-1 (0.6)	-11** (3.2)	-5** (1.8)	6 (3.2)
Preparing lessons	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.3)	-1 (0.6)	-4 (2.7)	0 (1.2)	3 (2.7)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Teachers' use of ICT

Teachers reported the frequency ("never," "less than once a month," "at least once a month but not weekly," "at least once a week but not every day," or "every day") of their use of ICT within and outside school for teaching, as well as for other work-related and non-work-related purposes.

Figure 4.2 shows the percentages of teachers for each group who used ICT every day for various purposes in Denmark, Finland, and Uruguay in 2018 and 2020. The figure offers little evidence that the SES gap widened from 2018 to 2020; rather, the differences turned out to be small in both years. The only deviation from this general pattern related to the use of ICT ***outside school for work-related purposes*** in Uruguay. Here, teachers in high SES schools were 14% more likely to report using ICT daily for work outside school in 2018, while in 2020 this difference almost completely disappeared (4%; see Table 4.2). The reduction in the SES gap in this context is statistically significant.

Figure 4.2: Percentages of teachers who reported using ICT every day by SES group and study cycle

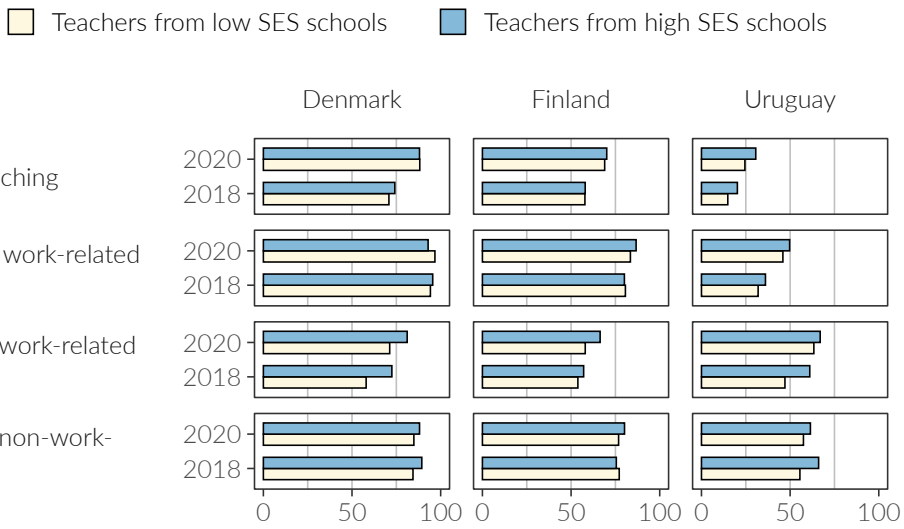


Table 4.2: Changes in SES gaps in the percentages of teachers who reported using ICT every day

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
At school when teaching	3 (6.0)	0 (3.6)	-3 (6.8)	0 (2.7)	1 (2.8)	1 (3.2)	5 (4.0)	6 (4.6)	1 (5.1)
At school for other work-related purposes	1 (2.4)	-4 (2.4)	-5 (3.4)	-1 (2.5)	3 (2.4)	4 (3.0)	4 (5.8)	4 (5.8)	0 (7.2)
Outside school for work-related purposes	14* (7.0)	10 (6.5)	-5 (5.4)	3 (3.9)	8* (3.4)	5 (3.7)	14* (6.3)	4 (6.5)	-10* (4.3)
Outside school for non-work-related purposes	5 (3.8)	3 (3.4)	-2 (4.0)	-2 (2.5)	3 (2.5)	5 (2.6)	11 (6.0)	4 (6.5)	-7 (7.2)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Teachers' ICT-related self-efficacy

ICILS asked teachers to rate how well they can do a range of different ICT tasks ("I know how to do this," "I haven't done this but I could find out how," and "I do not think I could do this"). The percentages of teachers who reported that they knew how to do each of the tasks for both SES groups and time points are shown in Figure 4.3. In addition, the difference in the percentages of teachers across SES groups and the change in the SES gap are reported in Table 4.3.

It can be seen that for most tasks there were small and not significant differences between teachers from the two SES groups. In Denmark, a significant SES gap was observed in both years for one task: ***using a spreadsheet program for keeping records*** with more teachers from lower SES schools having reported feeling confident in using ICT for this purpose. In Finland, a similarly directed difference (higher frequency of teachers in lower SES schools) was observed for the task: ***use a learning management system***. No changes in the SES gaps between 2018 and 2020 were significant in either Denmark or Finland.

In Uruguay, the SES gaps significantly changed for three tasks: ***contribute to a discussion forum on the Internet***, ***use the Internet for online purchases and payments*** and ***prepare lessons that involve the use of ICT by students***. In the last two tasks, the SES gaps were significant in 2018, and in 2020, no longer significant. For the ICT task ***contribute to a discussion forum on the Internet*** the differences within the years 2018 and 2020 were not significant for teachers in the two SES groups of schools. Although the SES gaps were not significant in 2018, they did significantly decrease in 2020, when no differences between the teachers from two SES groups were observed.

Figure 4.3: Percentages of teachers who reported that they knew how to do different ICT tasks by SES group and study cycle

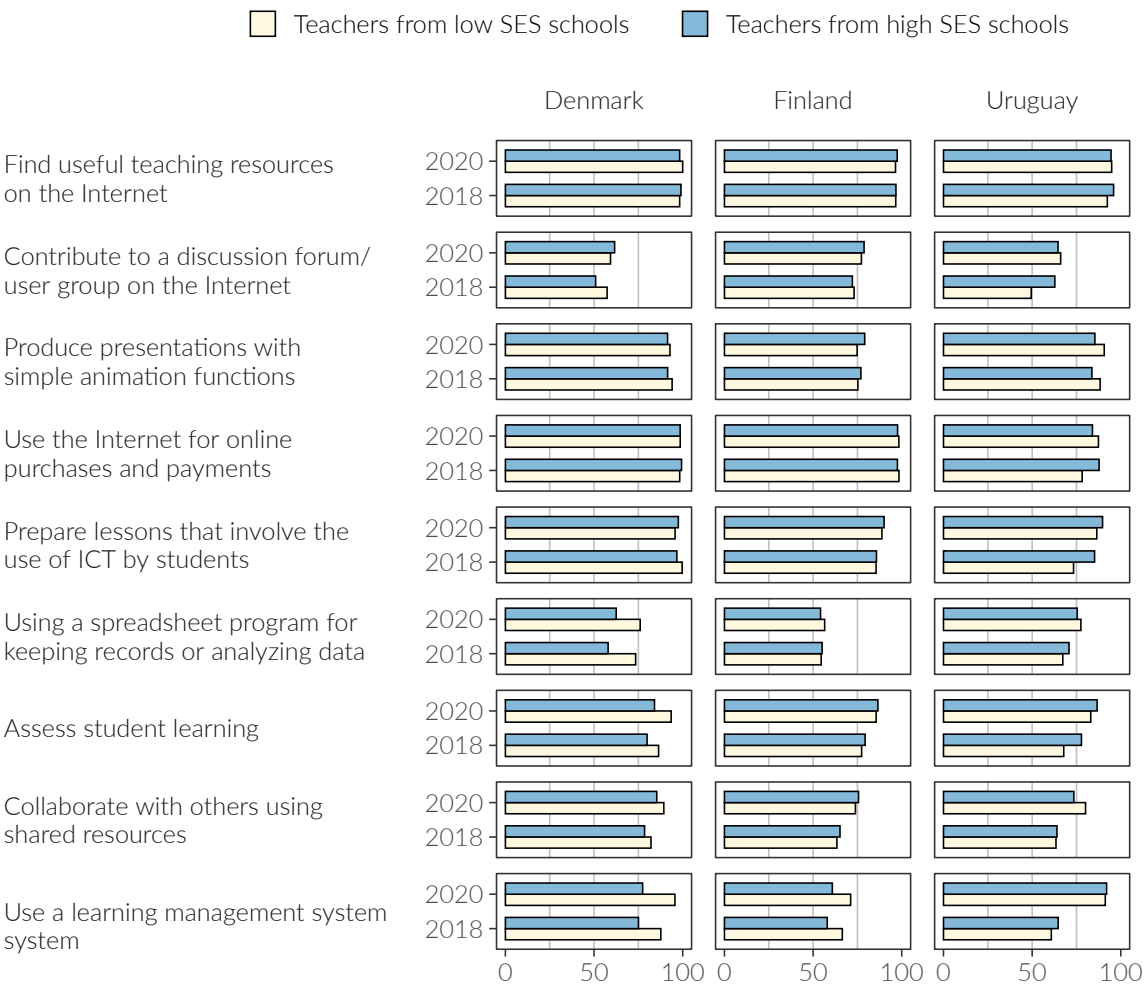


Table 4.3: Changes in SES gaps in the percentages of teachers who reported that they knew how to do different ICT tasks

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Find useful teaching resources on the Internet	1 (1.5)	-2* (0.8)	-2 (1.7)	0 (1.3)	1 (1.2)	1 (1.2)	4 (3.1)	0 (2.8)	-4 (3.9)
Contribute to a discussion forum/ user group on the Internet	-6 (6.0)	2 (6.3)	9 (8.3)	-1 (3.1)	2 (2.4)	2 (2.5)	13 (6.8)	-1 (5.0)	-15* (6.3)
Produce presentations with simple animation functions	-3 (2.4)	-1 (2.7)	1 (3.1)	2 (2.8)	4 (3.0)	3 (2.6)	-5 (4.1)	-5 (3.8)	-1 (4.0)
Use the Internet for online purchases and payments	1 (1.0)	0 (1.5)	-1 (1.8)	-1 (0.9)	-1 (0.9)	0 (1.0)	10* (3.9)	-3 (4.0)	-13* (5.5)
Prepare lessons that involve the use of ICT by students	-3* (1.3)	2 (2.5)	5 (2.9)	0 (2.1)	1 (2.0)	1 (2.2)	12* (4.9)	3 (3.7)	-9* (4.0)
Use a spreadsheet program for keeping records or analyzing data	-16** (4.4)	-14** (4.6)	2 (4.0)	1 (2.9)	-2 (3.1)	-3 (2.2)	4 (5.7)	-2 (4.2)	-6 (4.4)
Assess student learning	-6 (5.1)	-9** (3.3)	-3 (4.7)	2 (2.9)	1 (2.2)	-1 (2.4)	10 (5.5)	4 (4.2)	-6 (5.9)
Collaborate with others using shared resources	-4 (5.5)	-4 (3.5)	0 (4.8)	2 (3.6)	2 (3.5)	0 (3.2)	1 (6.1)	-7 (4.8)	-7 (6.9)
Use a learning management system	-13 (7.2)	-18** (5.0)	-6 (7.1)	-8* (3.7)	-10** (3.9)	-2 (2.7)	4 (6.1)	1 (3.4)	-3 (5.2)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Teachers' views on using ICT in teaching and learning

Teachers were asked about their level of agreement or disagreement ("strongly agree," "agree," "disagree," or "strongly disagree") with statements about positive outcomes of using ICT for teaching and learning. Figure 4.4 presents the percentages of teachers who agreed or strongly agreed with the statements for both SES groups and time points. Overall, no apparent differences between teachers from higher SES and lower SES schools were observed. The only significant difference was observed in Denmark, for teachers agreeing with the statement ICT ***helps students develop greater interest in learning***. There was no difference in the agreement of this statement in year 2018, but in 2020 fewer teachers from higher SES schools and more teachers from lower SES schools agreed with this statement (see Table 4.4).

In addition, teachers' were also asked about their level of agreement or disagreement ("strongly agree," "agree," "disagree," or "strongly disagree") with statements about negative outcomes using ICT for teaching and learning. In Figure 4.5, the percentages of teachers who agreed or strongly agreed with the statements are presented for both SES groups and time points. Generally, the SES gap in teacher responses from the two SES groups were very small in Denmark and Finland, while larger differences were observed in Uruguay. Table 4.5 suggests that no significant differences were observed in Denmark. In Finland, an SES gap was observed in 2018 for the statement ICT ***limits the amount of personal communication among students*** with about 6% more teachers from schools with higher SES agreeing with this statement compared to teachers from schools with lower SES. This difference decreased in 2020, but the decrease was not statistically significant.

Figure 4.4: Percentages of teachers agreeing with statements about positive outcomes of using ICT for teaching and learning by SES group and study cycle

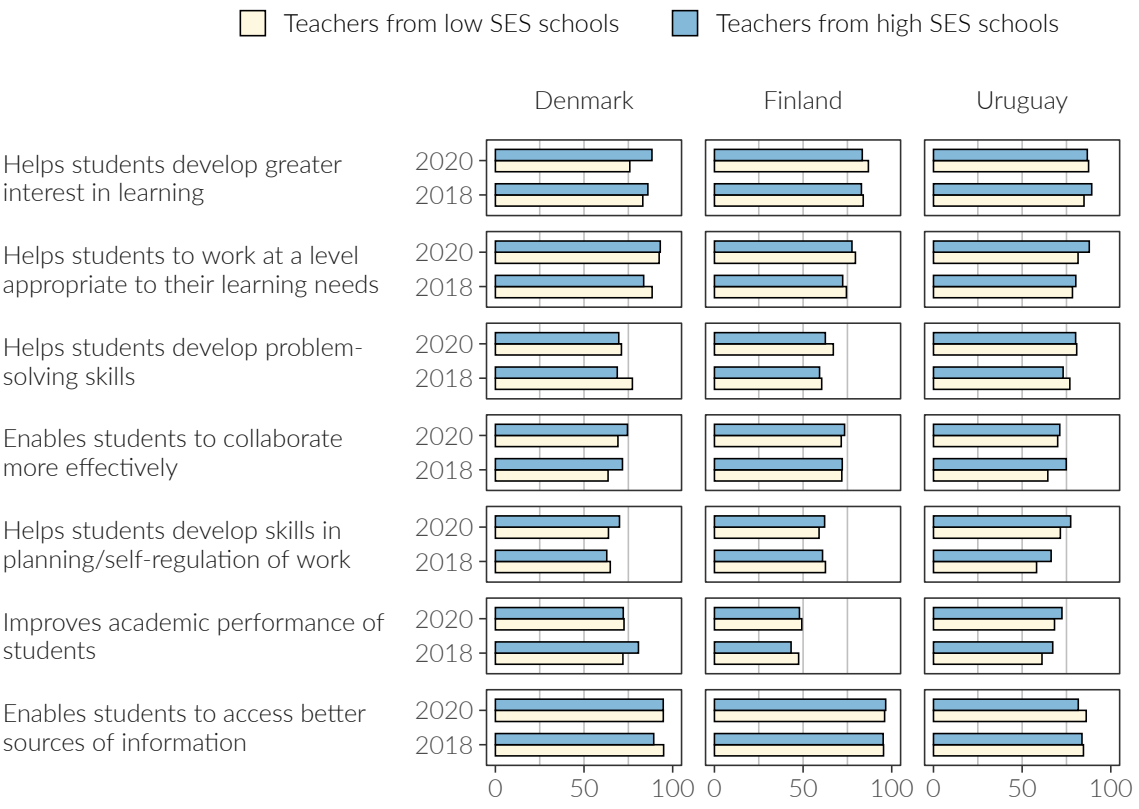


Table 4.4: Changes in SES gaps in the percentages of teachers agreeing with statements about positive outcomes of using ICT for teaching and learning

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Helps students develop greater interest in learning	3 (4.6)	13** (4.8)	10* (4.7)	-1 (2.4)	-3 (2.2)	-2 (2.5)	4 (3.6)	-1 (4.7)	-5 (5.0)
Helps students to work at a level appropriate to their learning needs	-5 (5.4)	1 (2.5)	5 (6.3)	-2 (3.3)	-2 (2.6)	0 (3.2)	2 (4.9)	6 (5.1)	4 (6.6)
Helps students develop problem-solving skills	-9 (6.6)	-2 (6.9)	7 (6.5)	-1 (3.1)	-4 (2.8)	-3 (3.9)	-4 (5.8)	-1 (4.7)	3 (6.2)
Enables students to collaborate more effectively	8 (7.5)	5 (6.1)	-3 (7.2)	0 (2.8)	2 (2.6)	2 (3.4)	10 (6.0)	1 (5.9)	-9 (7.0)
Helps students develop skills in planning/self-regulation of work	-2 (7.5)	6 (6.0)	8 (7.4)	-2 (3.5)	3 (2.7)	5 (3.6)	8 (6.8)	6 (6.3)	-2 (7.5)
Improves academic performance of students	9 (5.0)	0 (4.8)	-9 (5.4)	-4 (3.3)	-1 (3.0)	3 (3.2)	6 (7.5)	4 (5.2)	-2 (7.1)
Enables students to access better sources of information	-6 (3.0)	0 (3.6)	6 (5.2)	0 (1.3)	1 (1.0)	1 (1.6)	-1 (4.4)	-4 (4.7)	-4 (6.2)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

In Uruguay, there were differences between teachers from the two SES groups in their agreement on the following two statements: using ICT for teaching and learning ***results in students copying material from the Internet*** and ***distracts students from learning***. No gaps were observed in 2018, but in 2020 an increase of 14 percentage points and 11 percentage points was observed in teachers agreement with the statements, from schools with lower SES compared to higher SES schools, respectively. However, the increases between 2018 and 2020 were not significant. In addition, there were differences in their agreement with the statement that the use of ICT for teaching and learning ***results in poorer calculation skills among students*** in 2018. An increase of about 12 percentage points was observed in teachers agreement with the statement from schools with lower SES compared to schools with higher SES, and this SES gap was significant. In 2020, this gap decreases, with the difference between teachers from the two SES groups not being significant.

Figure 4.5: Percentages of teachers agreeing with statements about negative outcomes of using ICT for teaching and learning by SES group and study cycle

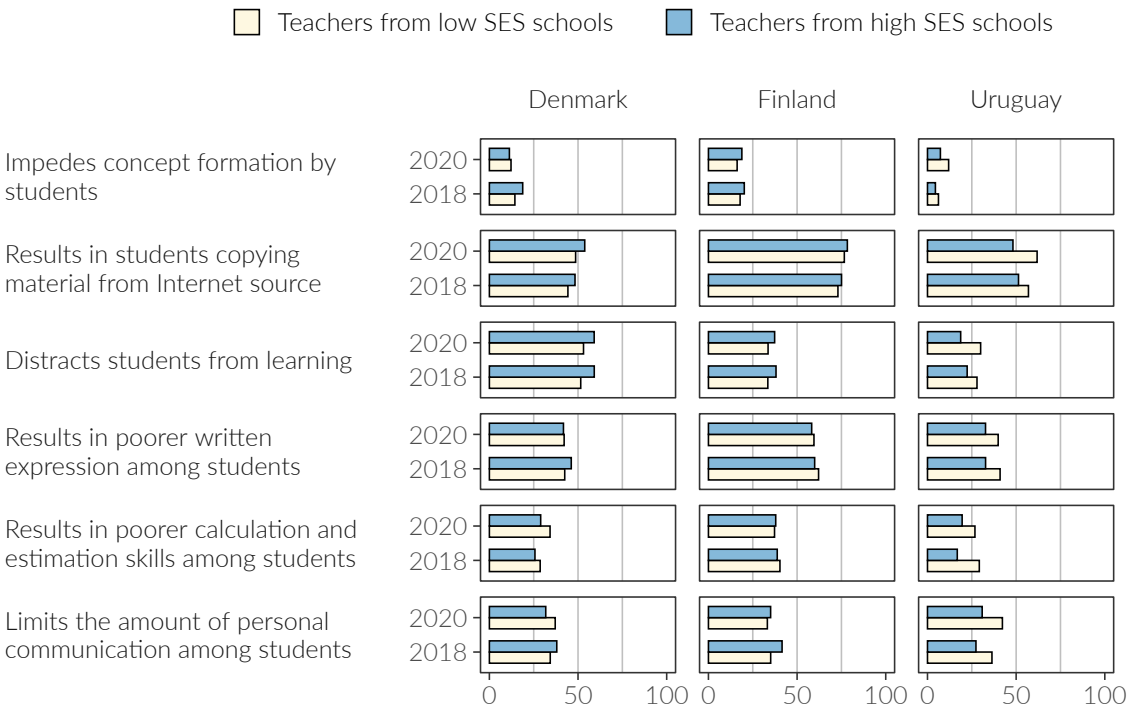


Table 4.5: Changes in SES gaps in the percentages of teachers agreeing with statements about negative outcomes of using ICT for teaching and learning

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Impedes concept formation by students	4 (4.2)	-1 (3.1)	-5 (4.5)	2 (2.5)	3 (2.6)	0 (2.8)	-2 (2.9)	-5 (3.7)	-3 (4.6)
Results in students copying material from Internet sources	4 (6.8)	5 (7.5)	1 (6.1)	2 (2.7)	2 (2.7)	0 (3.4)	-6 (5.7)	-14* (5.8)	-8 (5.7)
Distracts students from learning	8 (7.4)	6 (6.8)	-2 (4.5)	5 (3.3)	4 (3.5)	-1 (3.5)	-6 (5.8)	-11* (4.8)	-6 (6.7)
Results in poorer written expression among students	4 (5.2)	0 (7.3)	-4 (7.0)	-2 (3.2)	-1 (2.8)	1 (3.8)	-8 (7.4)	-7 (7.4)	1 (9.2)
Results in poorer calculation and estimation skills among students	-3 (5.1)	-5 (5.3)	-2 (5.9)	-2 (3.7)	1 (3.2)	2 (3.7)	-12* (5.3)	-7 (5.0)	5 (6.1)
Limits the amount of personal communication among students	4 (7.2)	-5 (7.0)	-9 (9.5)	6* (2.8)	2 (2.6)	-5 (3.2)	-9 (5.6)	-11 (6.2)	-2 (7.4)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

4.2.2 Teachers' perceptions of the schools' ICT learning environments

Teachers' perceptions of the availability of ICT resources at school

Teachers reported their level of agreement or disagreement ("strongly agree," "agree," "disagree," or "strongly disagree") with statements about the availability of ICT for teaching at school. Figure 4.6 shows the percentages of teachers from both SES groups who agreed or strongly agreed with several such statements in Denmark, Finland, and Uruguay in 2018 and 2020. The figure offers little evidence that the SES gap between teachers from each SES group increased from 2018 to 2020. However, we observed some specific significant differences in Denmark and Finland. In Denmark, a significant SES gap between teachers was observed in 2020, in their agreement with the statement (there is) ***sufficient opportunity for me to develop expertise in ICT*** (see Table 4.6). While no significant differences between SES groups existed in 2018. In 2020, an increase of 16 percentage points was observed in teachers' agreeing with the statement in schools with higher SES.

Figure 4.6: Percentages of teachers agreeing with statements about the availability of ICT for teaching at school by SES group and study cycle

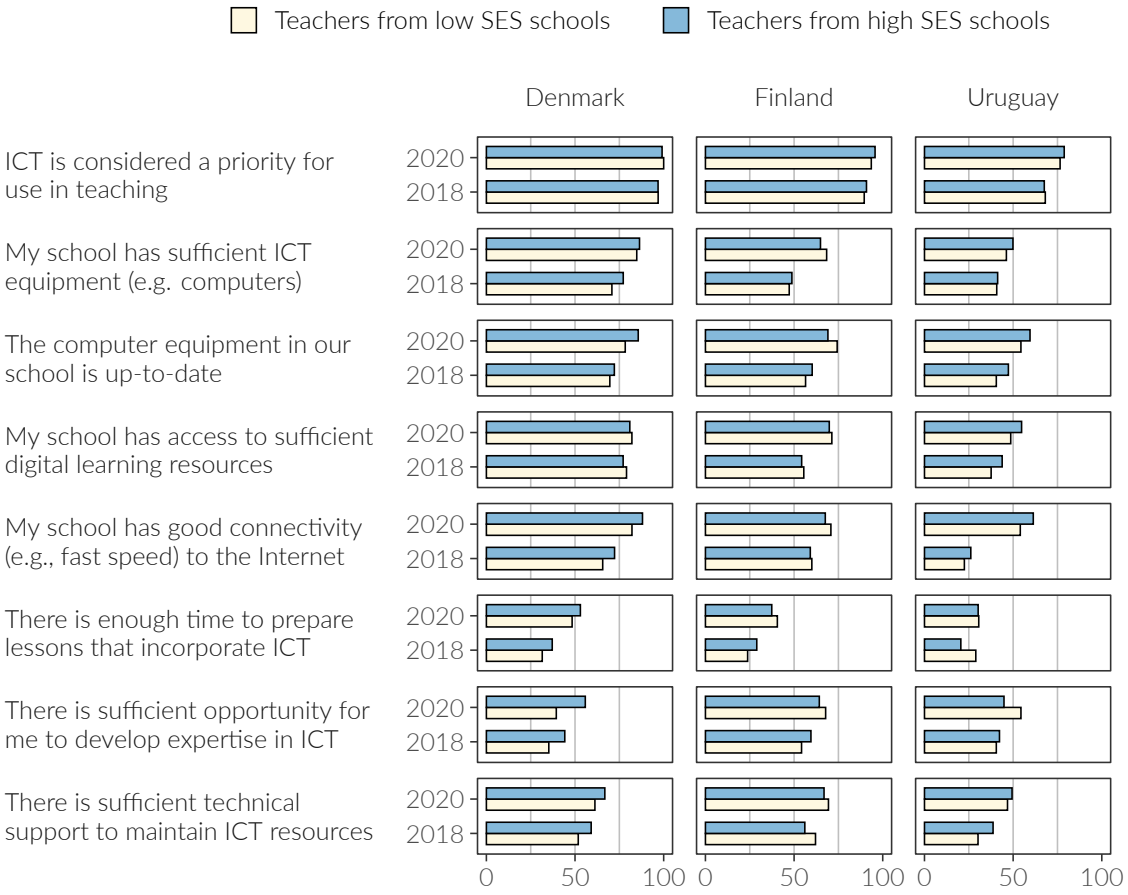


Table 4.6: Changes in SES gaps in the percentages of teachers agreeing with statements about the availability of ICT for teaching at school

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
ICT is considered a priority for use in teaching	0 (2.2)	-1 (0.9)	-1 (2.4)	1 (1.8)	2 (1.5)	1 (2.1)	-1 (6.1)	2 (5.8)	3 (6.7)
My school has sufficient ICT equipment (e.g. computers)	6 (5.2)	2 (4.1)	-5 (5.3)	2 (4.7)	-3 (5.0)	-5 (5.3)	1 (6.5)	4 (5.4)	3 (7.0)
The computer equipment in our school is up-to-date	3 (6.4)	7 (4.3)	5 (6.8)	4 (4.7)	-5 (4.9)	-9 (5.0)	7 (6.3)	5 (6.2)	-2 (6.0)
My school has access to sufficient digital learning resources	-2 (5.4)	-1 (6.0)	1 (5.0)	-1 (4.3)	-1 (3.5)	0 (4.3)	6 (6.6)	6 (6.1)	0 (7.4)
My school has good connectivity (e.g., fast speed) to the Internet	7 (6.2)	6 (5.0)	-1 (6.6)	-1 (4.7)	-3 (4.0)	-2 (4.8)	4 (6.4)	7 (6.6)	4 (8.8)
There is enough time to prepare lessons that incorporate ICT	6 (6.7)	5 (6.8)	-1 (5.4)	5 (3.3)	-3 (3.1)	-8** (3.1)	-8 (6.2)	0 (6.4)	8 (7.3)
There is sufficient opportunity for me to develop expertise in ICT	9 (6.4)	16* (7.2)	7 (6.1)	5 (3.8)	-4 (3.3)	-9* (4.2)	2 (6.7)	-10 (6.4)	-11 (8.2)
There is sufficient technical support to maintain ICT resources	7 (7.2)	6 (6.7)	-2 (7.0)	-6 (4.9)	-2 (4.3)	4 (4.9)	8 (6.7)	3 (6.2)	-6 (9.4)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

In Finland, significant changes in SES gaps were observed for the following two statements, (there is) ***enough time to prepare lessons that incorporate ICT*** and ***sufficient opportunity for me to develop expertise in ICT***. In both statements, we observed that in 2018 more teachers from schools with higher SES agreed with these statements, while in 2020, more teachers from schools with lower SES agreed with the statements. No significant differences and changes were observed in Uruguay.

Collaboration between teachers in using ICT

ICILS asked teachers about their perceptions of whether and how ICT is used as part of collaborative teaching and learning at their school and asked teachers about their agreement or disagreement with five statements regarding collaboration among colleagues regarding the use of ICT ("strongly agree," "agree," "disagree," or "strongly disagree").

Figure 4.7 shows the percentages of teachers agreeing with the statements for both SES groups, in 2018 and in 2020. No large patterns of SES gaps were evident, but from Table 4.7 some significant differences were observed in Finland and Uruguay. In Finland, a difference in the agreement between teachers in the different SES groups was observed in both 2018 and in 2020. Significantly more teachers from schools with higher SES agreed with two statements: ***I collaborate with colleagues to develop ICT based lessons*** and ***I share ICT-based resources with others in my school***. In Uruguay, in 2020 significantly more teachers in schools with students with higher SES compared to teachers in schools with students with lower SES agreed with the statement ***I discuss with other teachers how to use ICT in teaching***.

Figure 4.7: Percentages of teachers agreeing with statements about the collaborative use of ICT in teaching and learning by SES group and study cycle

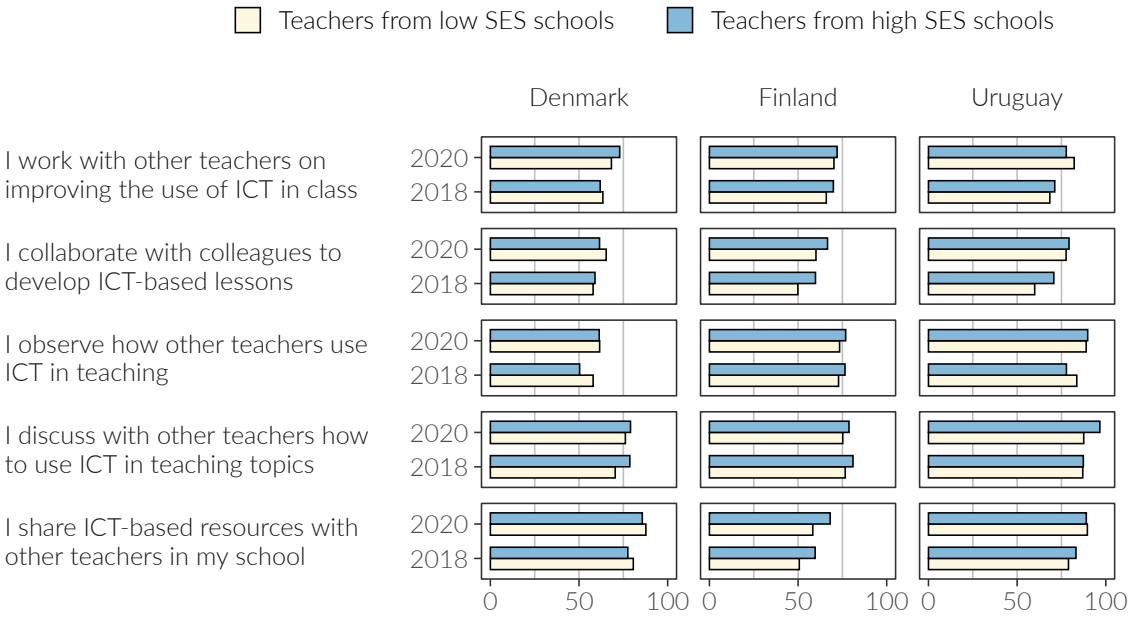


Table 4.7: Changes in SES gaps in the percentages of teachers agreeing with statements about the collaborative use of ICT in teaching and learning

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
I work with other teachers on improving the use of ICT in class	-2 (7.6)	5 (6.3)	6 (6.4)	4 (3.0)	2 (2.9)	-2 (3.2)	3 (6.3)	-4 (5.1)	-7 (8.0)
I collaborate with colleagues to develop ICT-based lessons	1 (6.2)	-4 (7.0)	-5 (7.5)	10** (3.4)	7* (3.1)	-3 (3.9)	11 (7.0)	2 (5.0)	-9 (8.9)
I observe how other teachers use ICT in teaching	-8 (7.0)	0 (5.5)	7 (6.2)	4 (3.0)	3 (2.8)	0 (3.4)	-6 (5.3)	1 (3.4)	7 (6.4)
I discuss with other teachers how to use ICT in teaching topics	8 (5.3)	3 (5.0)	-5 (5.8)	4 (2.9)	4 (2.2)	-1 (3.5)	0 (4.7)	9* (3.7)	9 (5.4)
I share ICT-based resources with other teachers in my school	-3 (4.7)	-2 (4.3)	1 (4.0)	9** (2.7)	10** (2.9)	1 (3.2)	4 (4.0)	-1 (4.1)	-5 (5.9)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

4.2.3 Teachers' emphasis on learning CIL and CT in their reference class

Teachers' emphasis on developing CIL-related skills

Teachers were asked to indicate the emphasis they had given to developing different CIL-related skills for students in the reference class (selecting from "strong emphasis," "some emphasis," "little emphasis," or "no emphasis").

Teachers' reported how much emphasis they give to developing CIL-related skills, and the results are presented in Figure 4.8. The percentages of teachers in both SES groups and time points, who reported giving some or strong emphasis to the statements, are depicted. In general, we observed that most teachers across the countries reported giving some or strong emphasis for most statements. In Table 4.8 differences between the two SES groups of teachers are presented. In Denmark, in 2020, a significant difference in the emphasis of teachers from schools of different SES groups was reported for the following two statements: ***to display information for a given audience*** and ***to understand consequences of publishing information online***. For both statements, significantly more teachers, 7 percentage points and 15 percentage points, respectively, in schools with higher SES reported giving some or strong emphasis to the statements. The difference in the reported emphasis occurred in 2020 and was not present in 2018. On the flip side, teachers' emphasis on providing references for digital information sources significantly differed between the two SES groups in 2018, but was not significant in 2020.

Figure 4.8: Percentages of teachers who reported giving some or strong emphasis to developing CIL-related skills in their reference class by SES group and study cycle

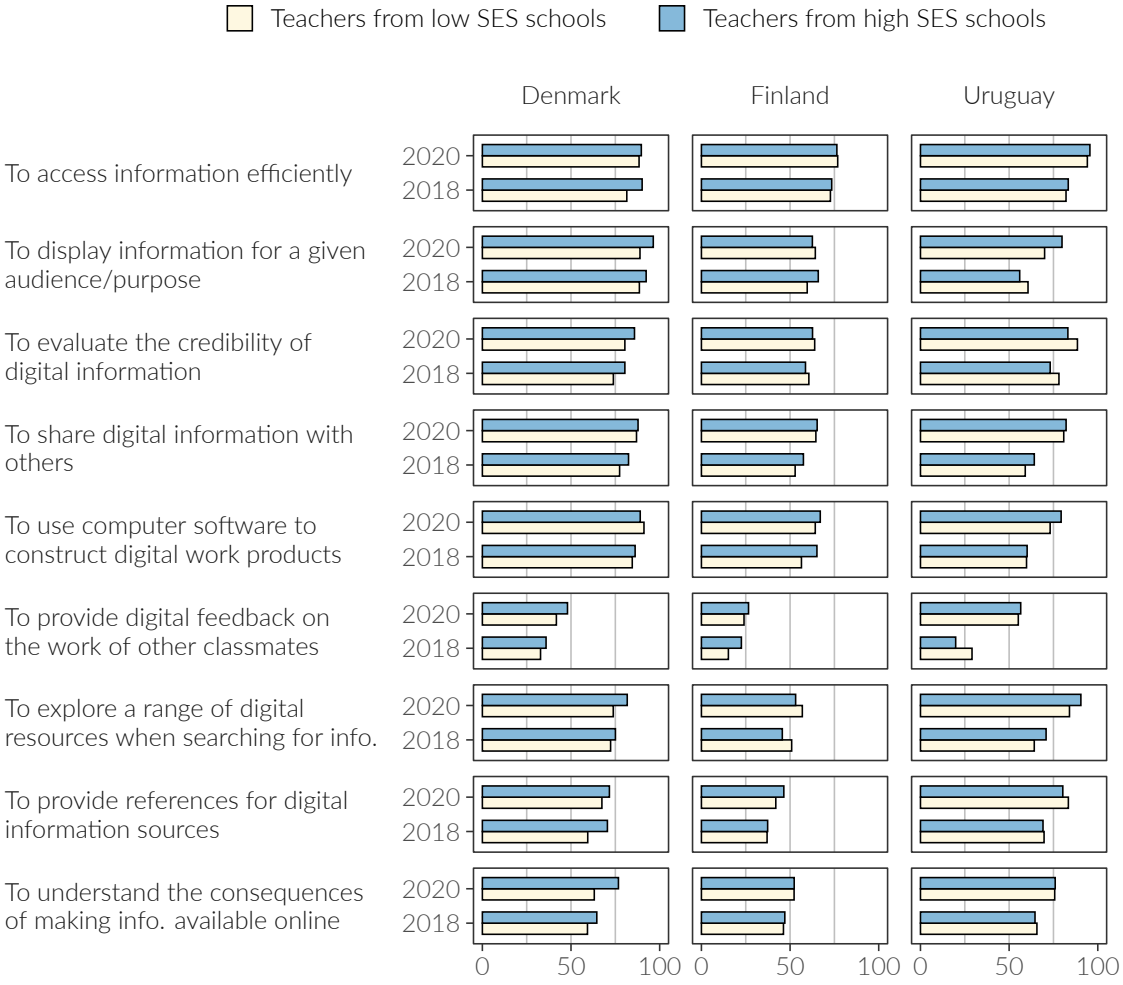


Table 4.8: Changes in SES gaps in the percentages of teachers reporting giving some or strong emphasis to developing CIL-related skills in their reference class

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
To access information efficiently	9 (4.5)	1 (5.5)	-7 (5.8)	1 (2.9)	0 (2.6)	-1 (2.9)	1 (4.8)	1 (2.8)	0 (4.7)
To display information for a given audience/purpose	4 (4.4)	7* (3.4)	4 (5.9)	6 (3.3)	-2 (2.9)	-8* (3.1)	-5 (5.8)	10 (5.2)	15* (7.0)
To evaluate the credibility of digital information	6 (5.2)	5 (4.3)	-1 (5.4)	-2 (2.9)	-1 (3.2)	1 (3.2)	-5 (5.8)	-5 (4.7)	0 (5.8)
To share digital information with others	5 (5.8)	1 (4.7)	-4 (5.6)	5 (3.7)	1 (3.5)	-4 (3.4)	5 (5.9)	1 (5.2)	-4 (6.7)
To use computer software to construct digital work products	2 (4.9)	-2 (3.5)	-4 (5.4)	9** (3.3)	3 (3.2)	-6 (3.0)	0 (4.8)	6 (4.8)	6 (5.8)
To provide digital feedback on the work of other classmates	3 (4.8)	6 (6.1)	3 (6.7)	7** (2.7)	3 (3.3)	-5 (3.2)	-9 (5.2)	1 (5.9)	11 (6.9)
To explore a range of digital resources when searching for info.	3 (5.2)	8 (5.4)	5 (7.0)	-5 (2.9)	-4 (3.4)	2 (3.6)	7 (6.4)	6 (3.3)	0 (6.7)
To provide references for digital information sources	11* (5.6)	4 (6.0)	-7 (5.5)	0 (3.6)	5 (3.5)	4 (3.3)	-1 (6.5)	-3 (4.6)	-3 (6.8)
To understand the consequences of making info. available online	5 (5.7)	14* (5.4)	8 (7.7)	1 (2.7)	0 (3.5)	-1 (3.5)	-1 (6.1)	0 (5.1)	1 (6.6)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

In Finland, significant gaps in teachers who reported giving some or strong emphasis were observed in 2018 for the following two statements: ***to use computer software to construct digital work products*** and ***to provide digital feedback on the work of others***. More teachers from schools with students with a higher SES reported on giving emphasis to these statements compared to teachers from schools with students with a lower SES. In both cases, the difference between the SES groups in 2020 was not significant. However, in Finland, there was a change in the SES gap for teachers reporting giving emphasis to the statement ***to display information for a given audience/purpose***, with a shift in the reported emphasis from a higher proportion of teachers in schools with higher student SES in 2018, to a slightly higher proportion of teachers in schools with lower student SES in 2020. While the differences between groups in both 2018 and 2020 were not significant, the change in the gap was significant. In contrast, in Uruguay, there was a significant increase in the reported gap in the emphasis given to the same statement between 2018 and 2020 (15 percentage points) which corresponds to a relative increase in the proportion of teachers from schools with students with a higher SES reporting that they gave some or strong emphasis to this skill in class.

Teachers' emphasis on developing CT-related skills

Teachers reported the emphasis they gave to developing CT-related skills for their instruction (selecting from "strong emphasis," "some emphasis," "little emphasis," or "no emphasis"). Again, the percentages of teachers who reported some or strong emphasis are presented in Figure 4.9 for both SES groups and time points. Similar to CIL skills, we observed many teachers reporting giving some or strong emphasis on developing CT skills in the years 2018 and 2020.

As can be seen from Table 4.9 no significant differences or changes were observed in Denmark and Finland. Only one significant difference was observed in Uruguay, for the statement ***to plan tasks by setting out the steps that need to be completed***. Significantly more teachers from schools with students with higher SES reported giving this some or strong emphasis compared to teachers from schools with students from a lower SES background.

Figure 4.9: Percentages of teachers who reported giving some or strong emphasis to developing CT-related skills in their reference class by SES group and study cycle

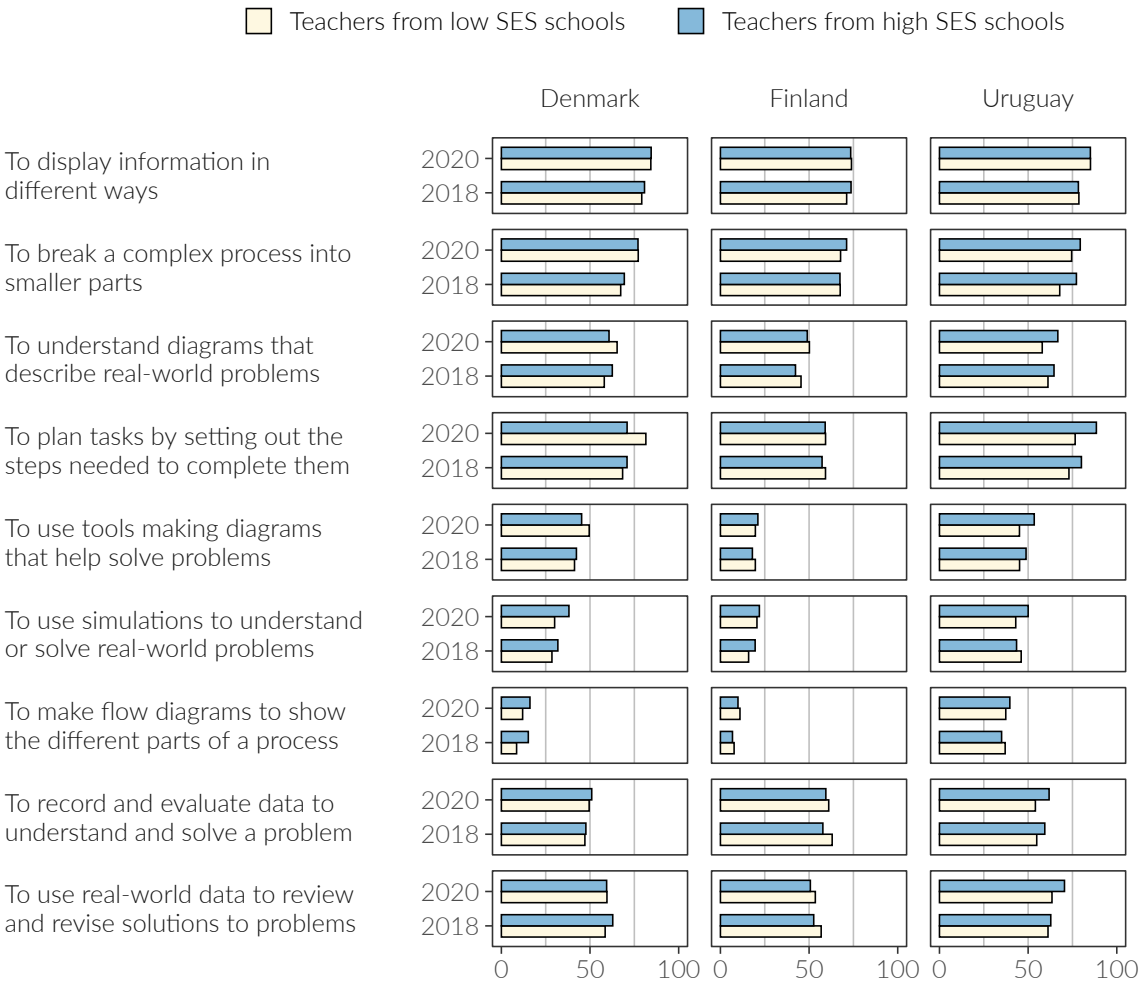


Table 4.9: Changes in SES gaps in the percentages of teachers reporting giving some or strong emphasis to developing CT-related skills in their reference class

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
To display information in different ways	2 (4.9)	0 (4.8)	-1 (6.3)	2 (2.5)	0 (2.8)	-3 (3.1)	0 (5.6)	0 (4.4)	0 (6.1)
To break a complex process into smaller parts	2 (5.6)	0 (4.3)	-2 (7.2)	0 (3.0)	3 (3.2)	4 (3.3)	9 (5.6)	5 (5.0)	-5 (5.4)
To understand diagrams that describe real-world problems	5 (6.7)	-5 (6.6)	-9 (5.4)	-3 (2.8)	-1 (2.9)	2 (3.0)	3 (6.4)	9 (6.7)	5 (6.1)
To plan tasks by setting out the steps needed to complete them	3 (6.3)	-11 (6.9)	-13 (7.7)	-2 (2.8)	0 (2.9)	2 (3.7)	7 (5.5)	12** (4.0)	5 (5.8)
To use tools making diagrams that help solve problems	1 (5.1)	-4 (5.0)	-5 (6.1)	-2 (2.4)	1 (2.4)	3 (2.2)	4 (6.7)	8 (6.8)	5 (9.2)
To use simulations to understand or solve real-world problems	3 (5.1)	8 (5.3)	5 (6.0)	4 (2.4)	1 (2.6)	-2 (2.4)	-3 (6.1)	7 (5.4)	10 (7.3)
To make flow diagrams to show the different parts of a process	7 (3.5)	4 (4.2)	-2 (5.2)	-1 (1.7)	-1 (2.1)	0 (2.4)	-2 (5.8)	2 (6.8)	4 (9.7)
To record and evaluate data to understand and solve problems	1 (6.6)	1 (6.4)	1 (6.8)	-5 (3.4)	-2 (3.5)	4 (3.5)	5 (6.0)	8 (7.1)	3 (10.0)
To use real-world data to review and revise solutions to problems	4 (5.5)	0 (6.6)	-4 (5.9)	-4 (2.9)	-3 (2.7)	1 (3.0)	2 (6.0)	7 (5.4)	5 (6.8)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

4.2.4 Teachers' use of ICT for teaching and learning in their reference class

Teachers' use of ICT tools

The teachers were asked to rate the frequency ("never," "in some lessons," "in most lessons," or "in every, or almost every lesson") of their use of general utility software and digital learning tools in the reference class during the current school year.

The use of general utility software is presented in Figure 4.10. The percentages of teachers who reported using the software in most lessons are presented across SES groups and time points. It was evident that ***spreadsheets*** and ***video and photo software for capture and editing*** were seldom used. No evident SES gaps were present in most of the statements across the countries.

Table 4.10 reveals some specific differences and SES gaps observed in Finland and Uruguay. In Finland in 2020, significantly more teachers from schools with students with a lower SES used ***computer-based information resources*** in most lessons compared to teachers from schools with students with higher SES. However, the difference was rather small (6 percentage points). In addition, a significant change in SES gaps was observed for the use of ***presentation software***. The gaps significantly increased in 2020 compared to 2018. In Uruguay, a significant gap was observed in 2020 for the use of ***video and photo software for capture and editing***. Nine percent more teachers from schools with students with higher SES used this software in at least most of the lessons compared to teachers from schools with students with lower SES.

Figure 4.10: Percentages of teachers who reported using general utility ICT tools in most lessons, almost every, or every lesson by SES group and study cycle

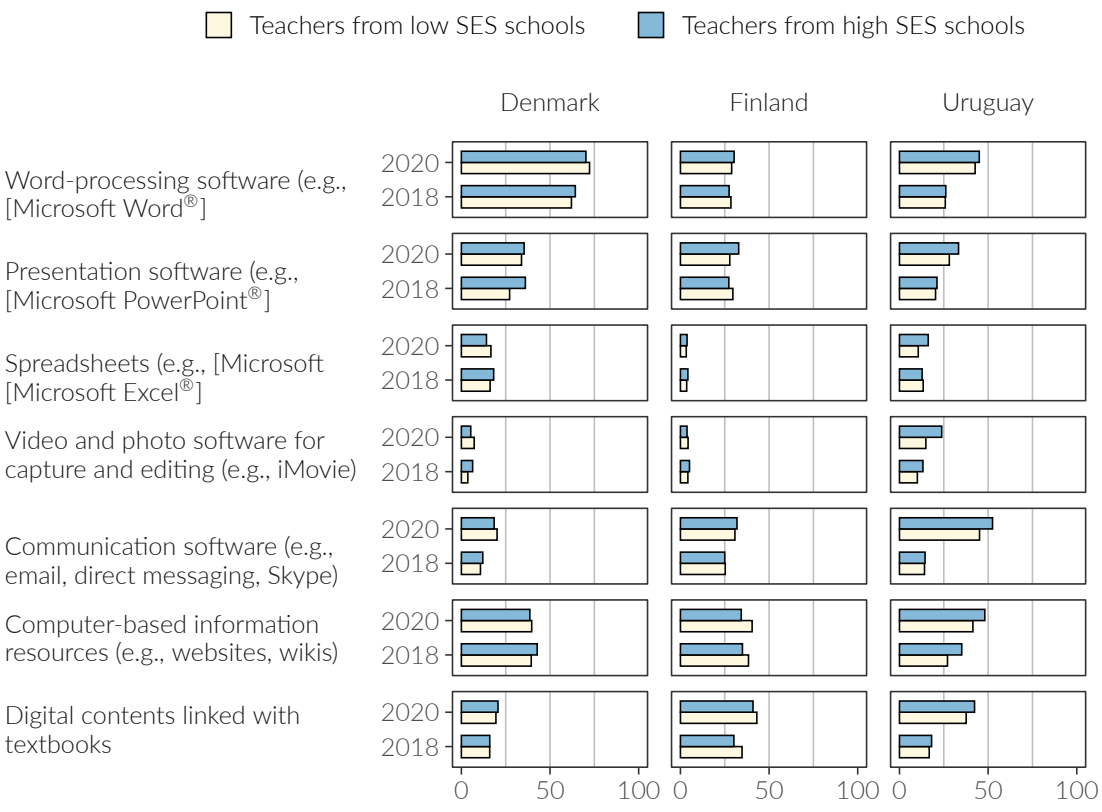


Table 4.10: Changes in SES gaps in the percentages of teachers who reported using general utility ICT tools in most lessons, almost every, or every lesson

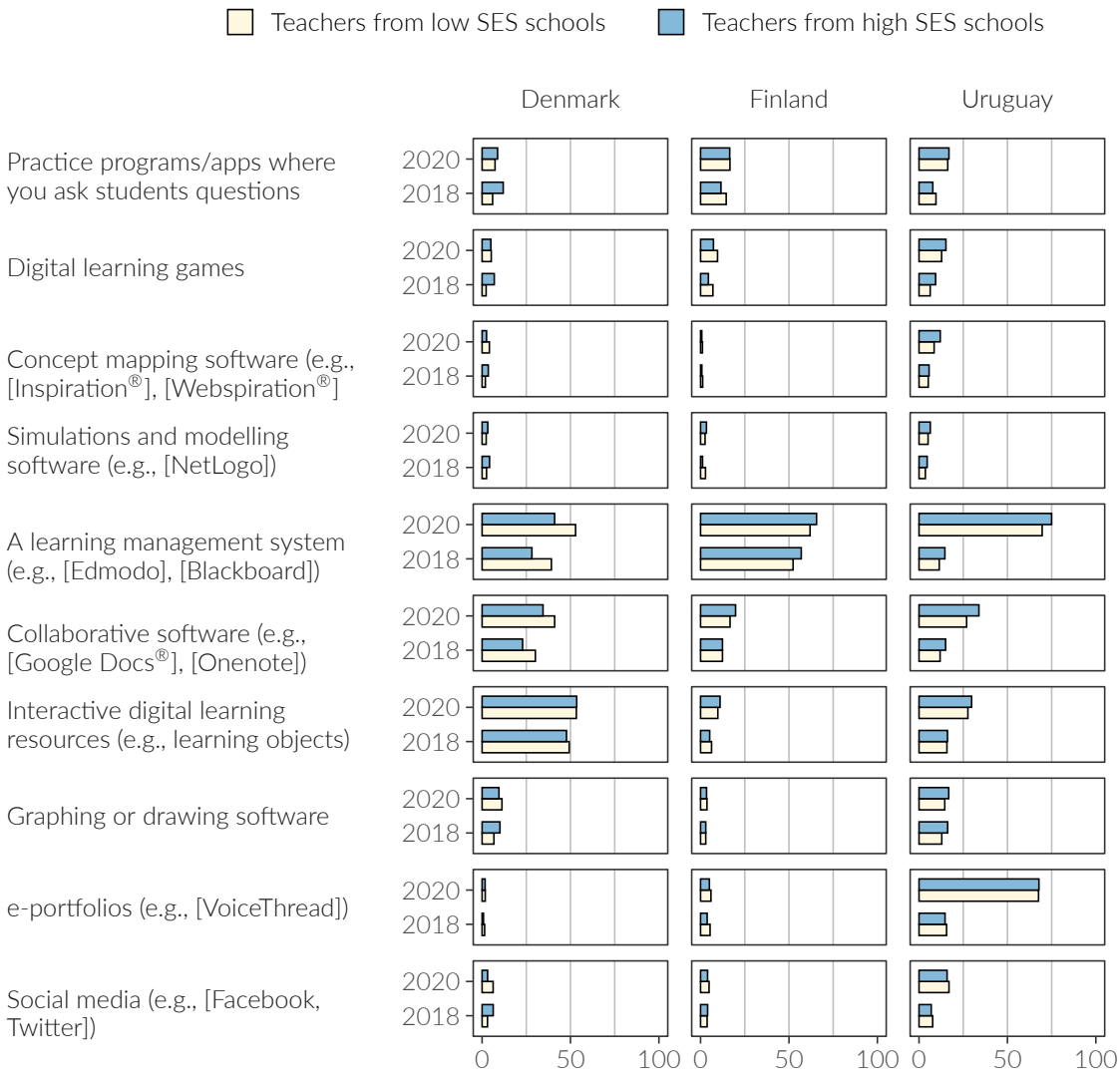
Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Word-processing software (e.g., [Microsoft Word®])	2 (6.3)	-2 (5.5)	-4 (7.7)	-1 (2.7)	1 (2.8)	2 (2.8)	0 (4.4)	2 (5.6)	2 (4.8)
Presentation software (e.g., [Microsoft PowerPoint®])	9 (5.5)	1 (5.6)	-7 (6.9)	-2 (2.3)	5 (3.1)	7** (2.8)	1 (4.5)	5 (5.6)	4 (5.8)
Spreadsheets (e.g., [Microsoft Excel®])	2 (4.2)	-3 (4.2)	-5 (5.4)	1 (1.3)	0 (1.1)	0 (1.5)	-1 (4.0)	6 (3.9)	6 (4.7)
Video and photo software for capture and editing (e.g., iMovie)	3 (2.3)	-2 (3.1)	-5 (3.7)	1 (1.3)	-1 (1.2)	-2 (1.3)	3 (3.6)	9* (4.0)	6 (4.3)
Communication software (e.g., email, direct messaging, Skype)	1 (3.3)	-2 (4.5)	-3 (5.6)	0 (3.0)	1 (2.6)	1 (2.4)	0 (4.1)	7 (5.4)	7 (6.3)
Computer-based information resources (e.g., websites, wikis)	3 (4.6)	-1 (5.7)	-4 (7.0)	-3 (3.3)	-6* (3.1)	-3 (3.7)	8 (5.7)	7 (6.2)	-1 (6.6)
Digital contents linked with textbooks	0 (4.5)	1 (3.8)	1 (5.2)	-5 (3.0)	-2 (3.4)	2 (4.0)	1 (4.2)	5 (6.2)	3 (6.0)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Another set of statements inquired into the use of digital learning tools. The percentages of teachers who used the tools in most lessons for both SES groups in the years 2018 and 2020 are presented in Figure 4.11. ***Simulations and modelling software*** was the least used across the countries, while the use of ***a learning management system*** was often used in lessons across the countries. But no significant SES gaps were observed within any of the participating countries.

In Table 4.11, SES gaps and changes in the use of ***digital learning tools*** are presented. A single significant SES gap was observed for the use of ***digital learning games*** in Denmark. In 2018, an increase of 5 percentage points was observed for teachers from schools with students with higher SES who used theses tools in most lessons. This SES gap was not evident in 2020 although the change in these gaps between the years was not significant.

Figure 4.11: Percentages of teachers who reported using digital learning ICT tools in most lessons, almost every, or every lesson by SES group and study cycle



Teachers' use of ICT for classroom activities

Teachers were asked to provide information about whether their students engaged in a set range of activities, and how often they used ICT as part of these activities ("they do not engage in this activity," "they never use ICT in this activity," "they sometimes use ICT in this activity," "they often use ICT in this activity," or "they always use ICT in this activity"). Figure 4.12 shows the results as percentages of teachers who reported that their students often or always used ICT for both SES groups, time points and across countries. Data from teachers who indicated that their students had not engaged in each of these activities were removed in these percentages.

It was evident that students in Denmark used ICT more often according to their teachers' reports compared to their peers' in Finland and Uruguay. No significant gaps were observed for teachers from the two SES groups of schools.

The differences between SES groups and the changes across years are presented in Table 4.12. No significant differences or changes were observed in Denmark. In Finland, a significant increase in the SES gap was observed for teachers' frequent use of ICT in ***explaining and discussing ideas with other students*** between 2018 and 2020, with a greater frequency of use reported by teachers at lower SES schools in 2018, and then this SES gap was reversed in 2020. The same was observed in Uruguay, with the SES gap

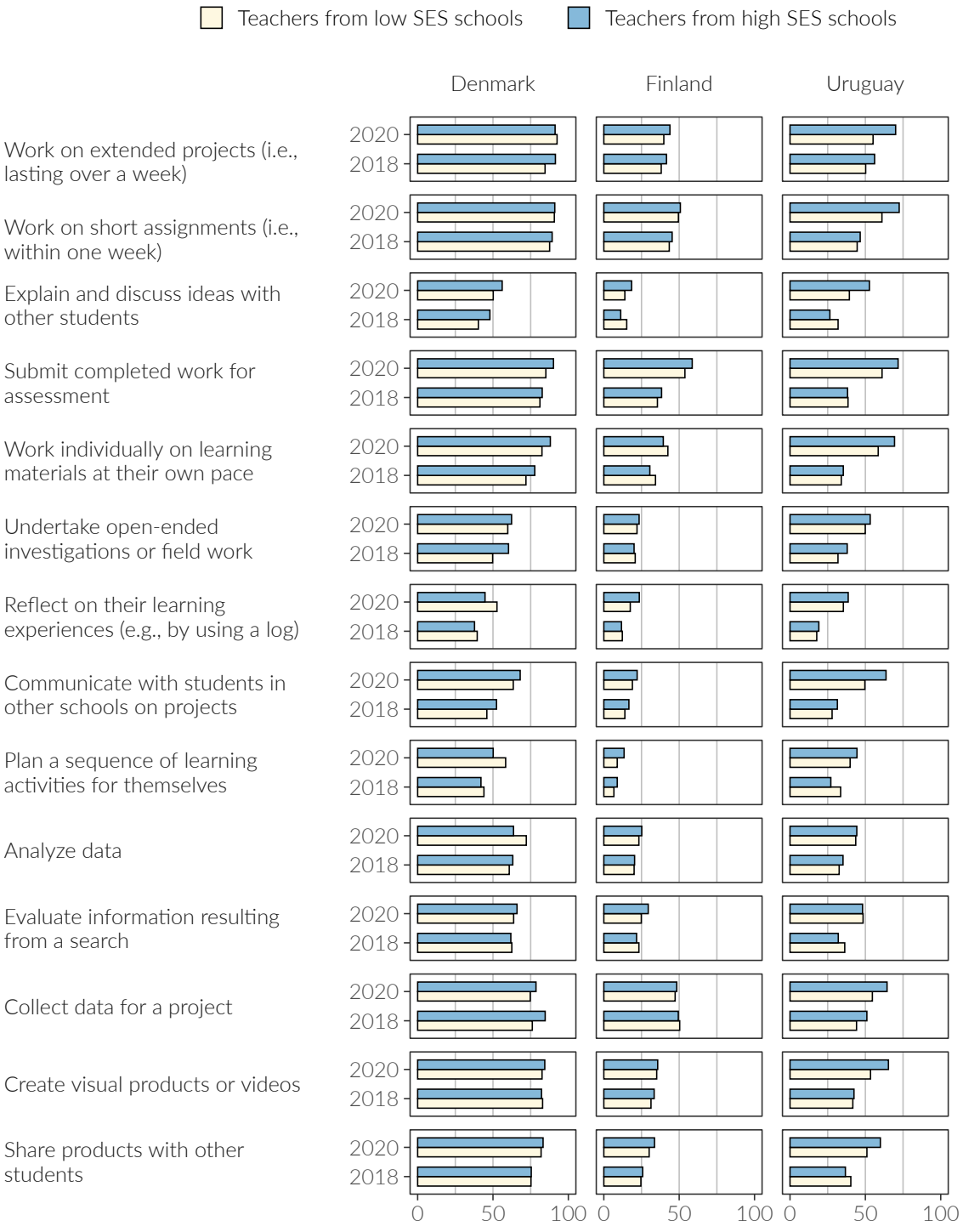
Table 4.11: Changes in SES gaps in the percentages of teachers who reported using digital learning ICT tools in most lessons, almost every, or every lesson

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Practice programs/apps where you ask students questions	6 (3.3)	1 (2.9)	-5 (3.5)	-3 (2.1)	0 (2.4)	3 (2.8)	-2 (4.6)	1 (4.7)	2 (5.5)
Digital learning games	5* (2.3)	0 (2.4)	-5 (2.7)	-3 (1.5)	-2 (1.9)	0 (2.2)	3 (3.7)	2 (4.8)	-1 (4.3)
Concept mapping software (e.g., [Inspiration®], [Webspiration®])	2 (1.9)	-2 (1.9)	-3 (2.7)	0 (0.6)	0 (0.6)	0 (0.9)	0 (2.6)	3 (3.1)	3 (3.8)
Simulations and modelling software (e.g., [NetLogo])	2 (2.1)	1 (1.6)	-1 (2.3)	-2 (0.9)	1 (1.0)	2 (1.3)	1 (2.6)	1 (2.7)	0 (3.3)
A learning management system (e.g., [Edmodo], [Blackboard])	-11 (7.1)	-12 (8.2)	-1 (7.2)	5 (3.6)	4 (2.7)	-1 (4.0)	3 (4.7)	5 (6.1)	2 (7.4)
Collaborative software (e.g., [Google Docs®], [Onenote])	-7 (5.2)	-7 (7.3)	1 (4.5)	0 (2.2)	3 (3.0)	3 (2.7)	3 (4.3)	7 (6.4)	4 (5.2)
Interactive digital learning resources (e.g., learning objects)	-2 (6.4)	0 (5.9)	2 (6.1)	-1 (1.7)	1 (1.9)	2 (2.2)	0 (5.0)	2 (5.4)	2 (6.3)
Graphing or drawing software	3 (2.9)	-2 (3.1)	-5 (3.7)	0 (1.0)	0 (1.1)	0 (1.3)	3 (4.8)	2 (3.9)	-1 (5.0)
e-portfolios (e.g., [VoiceThread])	-1 (1.0)	0 (1.4)	1 (1.8)	-2 (1.9)	-1 (1.6)	1 (1.3)	-1 (4.8)	0 (6.7)	1 (8.4)
Social media (e.g., [Facebook, Twitter])	3 (3.4)	-3 (2.3)	-6 (3.6)	0 (1.0)	-1 (1.4)	-1 (1.4)	-1 (2.9)	-1 (5.8)	0 (6.4)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

for this statement significantly increasing in 2020 with a significant difference between the two years (19 percentage points). Additionally, in Uruguay, in 2020 an increase of nearly 13 percentage points was observed for teachers reporting a frequent use of ICT for ***explaining and discussing ideas with other students*** from schools with students with higher SES compared to the teacher reports from schools with students with lower SES. Also in Uruguay, an increase of 15 percentage points was observed for teachers reporting having their students ***work on extended projects*** in schools with students with higher SES compared to the teachers reports from schools with students with lower SES, however, the change in this gap between

Figure 4.12: Percentages of teachers who reported that students used ICT often or always when engaging in different class activities by SES group and study cycle



2018 and 2020 was not significant.

Teachers' use of ICT for teaching practices

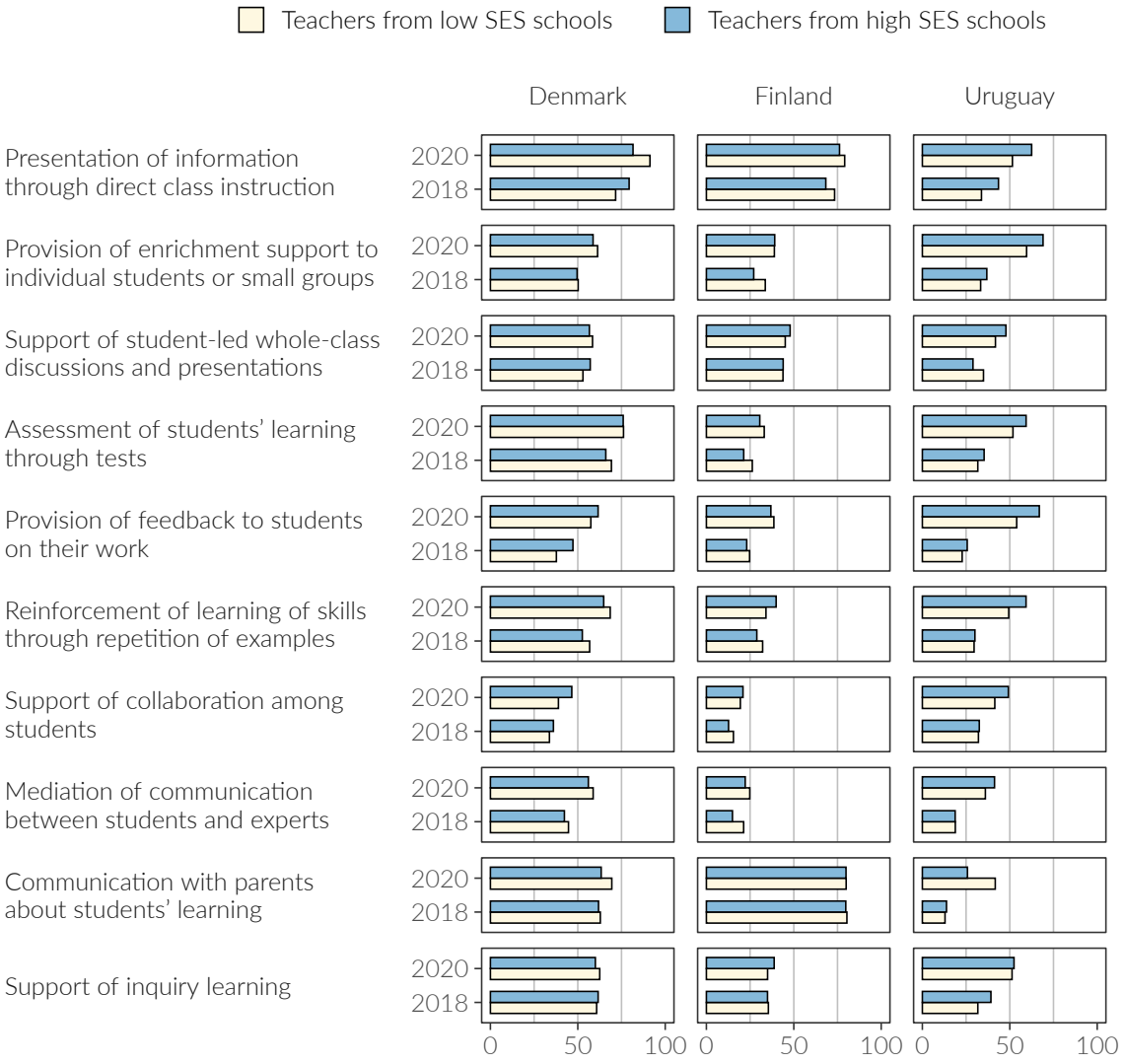
Teachers were also asked to report on their use of ICT for teaching practices and the frequency of use of ICT when applying them ("I do not use this practice with the reference class," "I never use ICT with this practice," "I sometimes use ICT with this practice," "I often use ICT with this practice," or "I always use ICT with this practice"). Again, Figure 4.13 illustrates the percentages of teachers who often or always used

Table 4.12: Changes in SES gaps in the percentages of teachers who reported that students used ICT often or always when engaging in different class activities

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Work on extended projects (i.e., lasting over a week)	7 (4.3)	-1 (3.6)	-8 (4.2)	3 (4.8)	4 (4.3)	1 (3.9)	6 (6.9)	15* (6.8)	9 (9.4)
Work on short assignments (i.e., within one week)	2 (3.8)	0 (3.4)	-1 (4.3)	2 (4.1)	1 (3.3)	-1 (3.9)	2 (6.5)	11 (6.4)	9 (8.1)
Explain and discuss ideas with other students	8 (6.7)	6 (5.8)	-2 (7.3)	-4 (2.7)	4 (2.7)	8** (2.5)	-5 (6.4)	13* (6.4)	19* (7.3)
Submit completed work for assessment	2 (4.8)	5 (3.7)	4 (5.6)	3 (4.5)	5 (4.1)	2 (4.5)	0 (6.3)	11 (5.6)	11 (8.9)
Work individually on learning materials at their own pace	6 (6.4)	6 (4.0)	0 (5.0)	-4 (3.8)	-3 (3.8)	1 (3.9)	1 (5.6)	11 (7.3)	9 (8.6)
Undertake open-ended investigations or field work	11 (6.4)	3 (6.5)	-8 (7.4)	-1 (3.4)	1 (3.6)	2 (3.5)	6 (7.3)	3 (9.9)	-3 (11.0)
Reflect on their learning experiences (e.g., by using a log)	-2 (5.6)	-8 (6.9)	-6 (7.6)	-1 (4.0)	6 (4.0)	7 (5.0)	1 (5.2)	3 (7.0)	2 (7.6)
Communicate with students in other schools on projects	6 (5.1)	5 (6.1)	-2 (6.3)	3 (3.5)	3 (4.1)	0 (4.4)	4 (7.4)	14 (9.4)	11 (7.9)
Plan a sequence of learning activities for themselves	-2 (6.2)	-8 (6.3)	-6 (8.1)	2 (3.6)	5 (3.9)	2 (4.2)	-7 (8.2)	5 (8.4)	11 (12.0)
Analyze data	2 (6.6)	-8 (5.3)	-11 (6.7)	0 (3.3)	2 (3.4)	2 (4.0)	3 (8.2)	1 (7.2)	-2 (10.2)
Evaluate information resulting from a search	-1 (5.6)	2 (5.4)	3 (7.1)	-2 (3.6)	5 (3.6)	6 (3.5)	-4 (6.5)	0 (8.0)	4 (8.5)
Collect data for a project	9 (4.4)	4 (5.6)	-5 (7.2)	-1 (3.6)	1 (3.9)	2 (4.1)	7 (6.7)	10 (6.3)	3 (6.6)
Create visual products or videos	-1 (3.9)	2 (5.1)	3 (4.1)	2 (4.7)	1 (3.9)	-1 (3.9)	1 (7.8)	12 (6.6)	11 (8.1)
Share products with other students	0 (6.4)	1 (4.1)	1 (6.4)	1 (4.3)	4 (3.6)	2 (3.8)	-4 (9.8)	9 (6.8)	13 (12.4)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

Figure 4.13: Percentages of teachers who reported using ICT for different teaching practices in most lessons, almost every, or every lesson by SES group and study cycle



ICT based on all teachers who reported using each of these practices for both groups and time points (teachers who did not use this practice with the reference class were excluded from the calculations). In general, few significant gaps were observed in Denmark, Finland, and Uruguay. From Table 4.13 a significant change in the SES gaps was observed in Denmark for ***presenting information through direct class instruction***. While in 2018 the gap was not significant between the two SES groups, in 2020 there were significantly more teachers in schools with students with lower SES reporting that they used ICT in direct class instruction in most lessons or more than most. For the same statement, a significant difference in Finland in 2018 was observed. An increase of about 5 percentage points was observed for teachers from schools with students with lower SES, that reported using ICT for this activity in most lessons, compared to teachers from schools with students with higher SES. The difference was not significant in 2020.

In Uruguay, one significant difference between the two SES groups of teachers was observed in 2020 that was not present in 2018. An increase of about 16 percentage points was observed for teachers reporting using ICT for ***communication with parents about student's learning*** from schools with students with lower SES, although the change in SES gap (a decrease of 17 percentage points) between 2018 and 2020 was not significant.

Table 4.13: Changes in SES gaps in the percentages of teachers who reported using ICT for different teaching practices in most lessons, almost every, or every lesson

Item	Denmark			Finland			Uruguay		
	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps	Gap 2018	Gap 2020	Δ in Gaps
Presentation of information through direct class instruction	8 (6.5)	-10* (4.0)	-17** (5.8)	-5* (2.5)	-3 (2.3)	2 (3.0)	10 (6.7)	11 (6.5)	1 (7.4)
Provision of enrichment support to individual students or small groups	-1 (6.6)	-3 (6.3)	-2 (7.2)	-7 (3.6)	0 (4.7)	7 (5.4)	4 (6.5)	9 (5.8)	6 (7.6)
Support of student-led whole-class discussions and presentations	4 (6.3)	-2 (5.8)	-6 (6.9)	0 (3.6)	3 (4.4)	3 (4.7)	-6 (6.9)	6 (6.7)	12 (7.4)
Assessment of students' learning through tests	-3 (5.5)	0 (4.9)	3 (5.9)	-5 (3.9)	-3 (4.2)	2 (4.5)	4 (5.4)	8 (6.3)	4 (7.7)
Provision of feedback to students on their work	9 (7.0)	4 (6.9)	-5 (6.7)	-2 (3.2)	-2 (4.0)	0 (4.3)	3 (5.5)	13 (7.1)	10 (9.1)
Reinforcement of learning of skills through repetition of examples	-4 (7.4)	-4 (5.2)	0 (7.1)	-3 (3.7)	6 (3.4)	9* (4.4)	0 (5.4)	10 (8.2)	9 (7.7)
Support of collaboration among students	2 (6.5)	8 (6.7)	5 (7.4)	-3 (2.6)	1 (3.4)	4 (3.5)	0 (6.1)	8 (6.2)	7 (5.9)
Mediation of communication between students and experts	-2 (7.2)	-3 (8.6)	0 (7.7)	-6 (3.7)	-3 (4.2)	4 (5.1)	0 (5.6)	5 (9.0)	5 (9.4)
Communication with parents about students' learning	-1 (5.8)	-6 (5.6)	-5 (5.7)	-1 (2.5)	0 (2.5)	1 (3.2)	1 (6.6)	-16* (7.3)	-17 (8.9)
Support of inquiry learning	1 (6.4)	-3 (5.2)	-3 (6.3)	0 (3.8)	4 (2.9)	4 (3.5)	7 (6.8)	1 (6.2)	-6 (8.4)

*Note: Gap 2018 = percentage of teachers from high SES schools minus from low SES schools in 2018; Gap 2020 = percentage of teachers from high SES schools minus from low SES schools in 2020; Δ in Gaps = Gap 2020 minus Gap 2018 (because percentages are rounded to the nearest whole number, some differences may appear inconsistent); standard errors in parentheses. These results should be interpreted with caution, given the relatively low panel response rates. See Chapter 6 and Appendix A for details on the samples and nonresponse. *$p < .05$, **$p < .01$.*

4.3 Summary

With the ICILS Teacher Panel data, we investigated the changes in social inequality in educational opportunities between 2018 and 2020. Responses from teachers coming from schools with students with higher SES and lower SES were compared. There is no clear evidence suggesting that the SES gaps systematically increased or decreased between 2018 and 2020 in all three countries. In fact, we observed mostly small opportunity gaps in 2018 and 2020.

Nevertheless, single cases of change can be observed. For example, in Finland, a significant change was estimated for teacher preparation time and opportunities to develop expertise in ICT and the change in SES gaps was significant. Teachers from schools with students with lower SES reported more time and opportunities than teachers from schools with students with higher SES in 2020 compared to 2018. In this case, the gaps decreased.

Another interesting finding from the ICILS Teacher Panel was observed in Finland and Uruguay. A significant gap was found for teacher responses to students use of ICT for explaining and discussing ideas with other students. The increase in gaps is significant. Teachers from schools with students with lower SES report less students using ICT for this activity in 2020 compared to 2018, than teachers from schools with students with higher SES. The data suggests that for this class activity, the gaps in Finland and Uruguay

increased. In general, gaps in fewer opportunities were observed in single years, and few increases and decreases in gaps were observed for single reports. As stated above, ICILS Teacher Panel offers no evidence of systematic increases or decreases in selected teaching and learning activities across Denmark, Finland and Uruguay.

Part II

Methods and Procedures

CHAPTER 5

Instruments and data collection

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Data collection for the present study began in November 2020 and continued through to the end of December 2020 in Finland and Uruguay, and through the end of March 2021 in Denmark. Given the varying contexts in the three participating countries (see Chapter 2), it was necessary to have flexible end dates for data collection.

Three instruments were used to understand the disruption caused by the COVID-19 pandemic to normal schooling practices, and to determine in what ways this disruption affected the use of ICT resource utilization for learning purposes. These instruments included a teacher questionnaire, an ICT Coordinators questionnaire and a questionnaire for school principals. To distribute these surveys in a timely manner, the infrastructure developed from previous ICILS studies was used. In each of the three participating countries, computer-based assessments were used in 2018 and 2020.

5.1 IEA Online Survey System

The IEA Online Survey System (OSS) is a tool used to collect survey information from participants in large-scale studies. For each participating education system, there was a webpage where participants enter a personal identification number and password, and are then admitted to an online survey where they provide responses to the questionnaire items. Participants can log out without completing the survey and login again anytime within the data collection period to complete and submit the survey. Upon entering the system, participants read instructions and can progress through the survey in numerical order, move backward through the survey, or access a table of contents page which displays which items they have completed, read but not yet completed, or not yet reached. From the table of contents, participants can select any item and be directed immediately to that item. Once a participant selects the "submit" option to complete the survey, they can no longer access the survey's content. Participants' responses are stored on the system while they navigate through the survey. If a participant responds to at least one item, their data is included in the study.

Each country's National Resource Coordinator (NRC) developed a communications strategy to contact participants in the survey. For more details on each country, please see Chapter 2. In general, school principals were contacted and once they agreed to participate, a list of personal identification numbers and passwords were given to the principal to distribute to the selected sample of teachers, and the school's ICT coordinator.

The OSS offered several advantages over the paper-based survey that were especially important given the state of the pandemic during the data collection phase. Firstly, no physical material was needed to contact schools and teachers. Rather, NRCs could choose to contact schools via email, sending all the necessary login information for the three questionnaires without the need for the exchange of physical material. In addition, as a number of schools in participating countries had restrictions on physical presence in school buildings, this process allowed schools to contact teachers via email with the necessary login information for each individual without the need for physical contact.

5.1.1 Challenges with data collection

There were several challenges associated with data collection for this study. Firstly, this study's design required a longitudinal sample, however, the study was not planned in advance but rather a response to the educational disruption caused by the COVID-19 pandemic. As a result, there was no existing infrastructure to re-contact those individuals who had participated in the ICILS 2018 study. While it was not necessary to have the same principals or ICT coordinators reporting from each school, the panel nature

of this study at the teacher level necessitated contacting the same teachers who participated in the 2018 study. In some participating countries, due to data-protection laws, lists of participants in the ICILS 2018 study were destroyed, meaning that the NRCs could only contact those schools that had participated in the 2018 study, and work with them to re-contact teachers who had also participated. Given the added workload to many schools due to varying working conditions, this process proved to be very difficult.

Another challenge related to the issue of high workloads in schools was that—in some countries—there was a reluctance from schools to participate given the strain they were already under to continue to provide education to students amid the global pandemic. Some principals or other school leadership felt teachers and staff were under tremendous pressure and the addition of other tasks would distract them from the real and difficult work the schools must do. Therefore, some schools declined to participate, resulting in data loss at both the school and teacher levels.

Each country had different strategies for contacting participants given the limitations they may have faced due to data protection laws, the hierarchy of the education system, reliance on mail and email use, or other considerations. As mentioned in Chapter 2, a variety of contact methods were used such as emails, phone calls, letters, and WhatsApp.

Within the sample of teachers from the 2018 study, some teachers had retired, some had moved schools, while others had moved to teach different subjects and/or grades. Teachers who had retired were out of scope of this study. For the teachers that had moved schools, efforts were made by each country to locate and contact those teachers and request their participation in the current study. Adding to the conundrum, whether a teacher remained at the same school or moved schools since participating in the ICILS 2018 study was also the possibility that they could be teaching a different grade level and/or subject.

Other challenges had to do with the timing of data collection. In Uruguay, the school year begins in January ending in December, meaning that data collection in the country could not extend beyond December, as the study aimed to collect data within a single school year. Extending data collection beyond the school year would have added complications, as teachers may begin teaching different subjects and grade levels, or move schools.

A noteworthy challenge concerning the timing of data collection was the occurrence of a predicted "second wave" of COVID-19 cases in Europe. As data collection began, school systems in several countries were moving back to online instruction from either hybrid online/physical presence learning, or full physical presence learning, and many individuals who were requested to participate in the current study noted the added work and stress during this time. Though there is no way to know how this may have affected participation rates, it was a noted challenge from NRCs when attempting to communicate with schools and teachers during data collection. Table 5.1 shows the participation rates for each sampled population in one-week intervals during the data collection stage of the present study.

This table includes all the responses from 2020. However, as may be observed, there were a number of respondents after December 2020 in both Finland and Uruguay. Some of the participants contacted in 2020 were part of the sample in 2018, but did not respond in 2018. Such cases were removed from the panel data. Therefore, Table 5.1 does not represent the final sample size for each country. Rather, it is a summation of data collection reflecting the challenges present due to the ongoing pandemic at the time of data collection. For further details on how the sample was cleaned for the panel study, please see Chapter 6.

5.2 Instruments and translations

This study included three instruments: a teacher questionnaire, an ICT Coordinator questionnaire, and a school principal questionnaire. Given the longitudinal nature of this study, many of the items on these three questionnaires were identical to the items from the previous ICILS 2018 study. With the present study being longitudinal, it was important to keep as many items as possible identical to their 2018 study counterparts to argue that the observed changes are attributable to the COVID-19 global pandemic. While no items were dropped, several items were added to collect specific information on the disruption caused by the COVID-19 pandemic.

Table 5.1: Weekly response rates (November 2, 2020 - April 4, 2021)

	Denmark			Finland			Uruguay		
Week	Teacher	ICT-C	Principal	Teacher	ICT-C	Principal	Teacher	ICT-C	Principal
Nov02 - Nov08				20	5	5			
Nov09 - Nov15	20	3	4	247	39	35	163	7	5
Nov16 - Nov22	7	1	2	292	27	27	27	10	3
Nov23 - Nov29	7	1	3	205	26	13	9	27	37
Nov30 - Dec06	8	1	1	238	14	20	130	4	3
Dec07 - Dec13	18	3	5	221	15	18	118	15	12
Dec14 - Dec20	9	1	3	104	10	12	130		12
Dec21 - Dec27				7	1	3	69	2	5
Dec28 - Jan03				4		1	68		
Jan04 - Jan10	18	2	4	3		1	13		
Jan11 - Jan17	13	5	2				2		
Jan18 - Jan24	12		1				1		
Jan25 - Jan31	25	9	3				1		
Feb01 - Feb07	4	2					1		
Feb08 - Feb14	32	6	8						
Feb15 - Feb21	6	3	4						
Feb22 - Feb28	229	24	34						
Mar01 - Mar07	44	5	5						
Mar08 - Mar14	29		1						
Mar15 - Mar21	10								
Mar22 - Mar28	7	1							
Mar29 - Apr04	2								

5.2.1 ICILS TP instruments

This section presents an overview of the international versions of each questionnaire. Of note, question numbers followed by the symbol "∗" were only administered if the participant provided an affirmative response to the previous question; section headers and question numbers followed by the symbol "+" were not administered in Denmark.

The ICILS Teacher Panel teacher survey was expected to take approximately 40 minutes to complete, compared to 30 minutes for the ICILS 2018 study. The ICILS Teacher Panel teacher survey asked about the teacher's background, their familiarity with ICT, their use of ICT in educational activities in teaching with a randomly selected reference class and the teacher's perceptions of ICT in schools and learning. The survey included up to 24 item prompts (see Figure 5.1 for details), for a total of 182 items.

Figure 5.1: Overview of the international version of the teacher survey

About You

Q1 Are you a female or male?
Q2 How old are you?
Q3 What are the main subjects that you teach in this school in the current school year?
Q4 In the current school year, at how many schools do you teach students?

Your Use of ICT

Q5 Approximately how long have you been using ICT for teaching purposes?
Q6 How often do you use ICT in these settings?
Q7 How well can you do these tasks using ICT?

Your Use of ICT in Teaching

Q7a For the current school year, which grades do you teach?
Q8 Which of the following best describes the subject for this reference class?
Q9 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?
Q10 How often do students in your reference class use ICT for the following activities?
Q11 How often do you use ICT with the following practices when teaching your reference class?
Q12 How often did you use the following tools in your teaching of the reference class this school year?
Q13 In your teaching of the reference class this school year, how much emphasis have you given to teaching the following skills?

In Your School

Q14 To what extent do you agree or disagree with the following statements about the use of ICT in teaching at your school?
Q15 To what extent do you agree or disagree with the following statements about your use of ICT in teaching and learning at your school?

Learning to Use ICT in Teaching

Q16 Did your <initial teacher education> include the following elements?
Q17 How often have you participated in any of the following professional learning activities in the past two years?

Approaches to Teaching

Q18 To what extent do you agree or disagree with the following statements about using ICT in teaching and learning at school?

COVID-19 Disruption^{+}

Q19^{+} COVID-19 provided a disruption to regular school activities, specifically the closure of school buildings. For how many weeks did your school keep its buildings (whether some or all) closed since the beginning of 2020?
Q20^{+} For the period specified above in item Q19, for how many weeks did you do the following?
Q21^{+} Before the COVID-19 disruption, how often did you do the following?

ICILS 2018 Study Questionnaire

Q22 Have you completed the teacher questionnaire for the ICILS study in the year 2018?
Q23* Did you complete the teacher questionnaire for the ICILS study in the year 2018 for this school?

Note: "$*$" were only administered if the participant provided an affirmative response to the previous question; section headers and question numbers followed by the symbol "+" were not administered in Denmark.

The ICILS Teacher Panel ICT Coordinator survey was expected to take 18 minutes, compared to 15 minutes for the 2018 study. The survey asked about ICT resources in the school (computers, other devices, digital learning resources, networking and Internet connectivity), ICT use in the school (provision for specialist teaching of ICT, emphasis on curriculum areas, learning management systems, school administration), ICT technical support (maintenance provision, support for managing resources), and provisions for professional development in ICT at school. The survey included up to 18 item prompts (see Figure 5.2 for details), for a total of 91 items.

Figure 5.2: Overview of the international version of the ICT coordinator survey

About Your Position

Q1 Do you, at your school, hold the position of technology or computer coordinator?
Q2 Which of the following teaching duties do you have?
Q3 How many years has your school been using ICT for teaching and/or learning purposes for students in <target grade>?

ICT Resources

Q4 Please indicate the availability of the following technology resources in your school.
Q5 Please indicate the availability of each of the following software resources at your school.
Q6 Please indicate the availability of the following technology facilities at <target grade>.
Q7a In your school, approximately how many of the following types of (school-provided) ICT devices are available?
Q7b Approximately, what percentage of all ICT devices in the school (include all types) are connected to the Internet?
Q7c In your school, about how many (school-provided) smart boards or interactive whiteboards are available?
Q8 Does your school or <educational authority> provide teachers with their own portable digital device?
Q9 Approximately what percentage of students at the <target grade> have access to portable computers (laptops, netbooks or tablet devices) at school?
Q10 Where are school ICT devices for teaching and learning in <target grade> located?

ICT Support

Q11 At your school, who provides <routine/day-to-day> technical ICT support?
Q12 At your school, who provides <routine/day-to-day> pedagogical ICT support for teachers?
Q13 To what extent is the use of ICT in teaching and learning at your school hindered by each of the following obstacles?
Q14 Is <computing, computer science, information technology, informatics or similar> taught as a standalone subject at the <target grade> in your school?
Q15* In the teaching of <computing, computer science, information technology, informatics or similar> at the <target grade> in your school, how much emphasis is given to the following tasks?

ICILS 2018 Study Questionnaire

Q16 Have you completed the ICT Coordinator questionnaire for the ICILS study in the year 2018?
Q17* Did you complete the ICT Coordinator questionnaire for the ICILS study in the year 2018 for this school?

Note: "∗" were only administered if the participant provided an affirmative response to the previous question; section headers and question numbers followed by the symbol "+" were not administered in Denmark.

The ICILS Teacher Panel school principal survey was expected to take 20 minutes, compared to 15 in the ICILS 2018 study. The survey collected information about school characteristics, policies, procedures, and priorities for ICT at the sampled school. The survey included up to 20 item prompts (see Figure 5.3 for details), for a total of 125 items.

Figure 5.3: Overview of the international version of the school principal survey

About You and Your Use of ICT

Q1 Are you female or male?
Q2 How often do you use ICT for the following activities?

Your School

Q3 What is the total number of boys and girls in the school?
Q4 What is the total number of boys and girls in <target grade>?
Q5a What is the lowest (youngest) grade that is taught at your school?
Q5b What is the highest (oldest) grade that is taught at your school?
Q6 What are the total numbers of full-time and part-time teachers in your school?
Q7 Which of the following best describes where your school is located?
Q8a Is this school a public or a private school?
Q8b Approximately what percentage of students in your school have the following backgrounds?

ICT and Teaching in Your School

Q9 How important is each of the following outcomes of education in your school?
Q10 Are there procedures in place to monitor whether teachers at this school use ICT to achieve the following learning outcomes?
Q11 Are teachers in your school expected to acquire knowledge and skills in each of the following activities?

Management of ICT in Your School

Q12 Who has the main responsibility for making decisions about each of the following aspects of ICT in this school?
Q13 Does your school or school system have policies with regard to the following aspects of ICT use?
Q14 Throughout the current school year, how many teachers in this school participate in the following forms of professional development about ICT for teaching and learning?
Q15 At your school, what priority is given to the following ways of facilitating the use of ICT in teaching and learning?

COVID-19 Disruption^{+}

Q16^{+} COVID-19 provided a disruption to regular school activities, specifically the closure of school buildings. For how many weeks did your school keep its buildings (whether some or all) closed since the beginning of 2020?

ICILS 2018 Study Questionnaire

Q17 Have you completed the principal questionnaire for the ICILS study in the year 2018?
Q18* Did you complete the principal questionnaire for the ICILS study in the year 2018 for this school?

Note: "$*$" were only administered if the participant provided an affirmative response to the previous question; section headers and question numbers followed by the symbol "+" were not administered in Denmark.

5.2.2 Reference class: modification of the 2018 Teacher Survey instrument

In ICILS 2013 and 2018, the target teacher population consisted of school staff members who taught regular school subjects to students of the target grade (regardless of the subject or the number of hours taught) during the testing period and since the beginning of the surveyed school year. The target grade

represented eight years of schooling, counting from the first year of the UNESCO International Standard Classification of Education (ISCED level 1). For most countries, the target grade was grade eight or its national equivalent. Schools eligible for ICILS studies are those at which target grade students are enrolled. Further details can be found in ICILS 2018 technical report Chapter 6 (Fraillon et al., 2020a).

In addition, to determine the extent to which teachers were using ICT in instruction, the teacher questionnaire asked about ICT use in a particular reference class. The reference class was defined as the first grade eight (or equivalent) class taught by the respondent for a regular subject (i.e., other than home room, assembly, etc.) on or after the last Tuesday before the respondent first accessed the questionnaire. Further details can be found in ICILS 2018 technical report Chapter 1 (Fraillon et al., 2020a).

For this panel study, which is not a regular cycle of ICILS, the target teacher population was determined differently. In ICILS Teacher Panel, the target population of teachers comprises all teachers eligible for ICILS 2018 except those who left the profession. Similarly, the target population of schools covers all schools eligible for ICILS 2018 that were still operating in 2020. Since some of the teachers sampled in the 2018 study may not have instructed grade eight in 2020, the reference class was adapted to the one that is "most similar" to grade eight. Working with each country, the ICILS Teacher Panel study established a hierarchy of grades that a teacher instructed, to determine the grade 'nearest' the grade eight as follows: grade 8, 9, 7, 6, 5, 4, 3, 2, 1, 10, 11, 12, 13, then 0. In Denmark, the grades from 0 to 10 were covered; in Finland, the grades from 1 to 13 were covered; and in Uruguay the grades from 7 to 12 were covered.

This order was established so that the ICT material taught would be as similar to grade eight as possible, if the teacher did not teach grade eight in 2020. If a teacher instructed just one grade in 2020, then that grade was selected. Otherwise, this hierarchy was established within the questionnaire software so that, after instructed grades were selected by a teacher, the following survey items would refer to the most relevant grade for selecting the reference class. For example, if a teacher reported that they taught grades seven and five (or their national equivalents), then the following questions were worded for grade seven when referring to a reference class. The reference class was identified similarly to the ICILS 2013 and 2018 studies. In other words, a comparable grade level taught in 2020 to the target grade level of 2018, which was grade eight (or equivalent), was found first. Afterward, the teacher selected a subject based on the reference class criteria of ICILS 2018.

For the purpose of this study, we assume the academic level of ICT content is similar across subjects within a specific grade level. Therefore, we are particularly concerned with knowing whether a teacher has changed a grade level from 2018 to 2020. However, we also recognize that ICT content is not uniform between different subjects, and have observed the differences. Table 5.2 shows the similarities and differences when comparing the grade and subject taught of each teacher in the ICILS Teacher Panel sample. The table presents numeric counts for each category and each country, along with unweighted percentages in parentheses. Each country had at least 45 percent of teachers instructing the same grade and subject as they did in 2018. Furthermore, at least 64 percent of teachers in all countries taught grade eight (or its equivalent), the target grade of ICILS 2018, meaning we assume the ICT content was largely similar between the two studies for these teachers and their students. In the ICILS Teacher Panel study, it was observed that a maximum of 13 percent of teachers taught different grades and subjects entirely from 2018 to 2020.

Table 5.2: Count and unweighted percentages of teachers instructing the same or different grades and classes in 2020 compared to 2018

	Denmark		Finland		Uruguay	
2020 to 2018 comparison	Count	(%)	Count	(%)	Count	(%)
Same grade, same subject	199	(45)	829	(67)	258	(55)
Same grade, different subject	111	(25)	209	(17)	43	(9)
Different grade, same subject	78	(17)	104	(8)	113	(24)
Different grade, different subject	57	(13)	104	(8)	54	(12)

5.2.3 Additions and other modifications to the 2018 instruments

As noted previously, the ICILS Teacher Panel questionnaires contained additional questions that addressed the disruption to normal schooling practices due to the COVID-19 pandemic. These questions were added to the teacher (Q19 through Q21) and principal (Q16) questionnaires. Furthermore, for all three questionnaires two item prompts (Q22 and Q23 for the teacher, Q16 and Q17 for the ICT coordinator, and Q17 and Q18 for the principal questionnaires) regarding the respondent's participation (or non-participation) in the ICILS 2018 study, were added. As mentioned previously, this study experienced attrition from the original 2018 sample, meaning not all participants from the 2018 study also participated in the present study. To note such cases, the variable PART in the data set identifies whether a teacher participated in only the ICILS 2018 study, coded 0, or in both studies, coded 1. For ICT coordinators and principals, the questionnaires focus on school-level details, as a result, finding the same individuals from the 2018 study was not necessary. Rather, the longitudinal interest was in the changing procedures at the school level, which both the ICT coordinator and principal could report, even if it was not the same individual as in 2018. Nevertheless, the variable PART identifies whether the school's ICT coordinator and principal participated in only the ICILS 2018 study.

While several item prompts changed and others were added, the format and functionality of the online questionnaires included the same capabilities as the OSS in 2018—in other words, no updates to the software were made for this study. For example, the OSS has the capability to omit specific items depending on the response to a previous item.

5.2.4 Instrument translations

Items that remained unchanged from the ICILS 2018 study used the same translations that had been approved for that study. The modified and additional items were sent to the NRCs of all participating countries for initial translations. In addition, countries translated the modifications to the questionnaire instructions. The translation were provided by either translation or language experts within the respective countries. These translations were then reviewed by external reviewers from the organization cApStAn—a recognized leader in quality assurance of translations—as an independent check. cApStAn experts look not only for linguistic verification of translations, but also for cultural suitability in psychological surveys, and they provide suggestions for improvement to the newly translated items and instructions. The countries then reviewed the recommendations and developed final versions of the translations for use in the study. Participants in Denmark completed the questionnaires in Danish, while those in Finland did so in either Finnish or Swedish, and those in Uruguay completed questionnaires in Spanish.

5.3 Data management and creation of the ICILS database

The ICILS Teacher Panel offered online collection of school and teacher questionnaire data. As respondents completed their online questionnaires, their data were automatically stored on the central international server. Data for each country-language combination were stored in a separate table on the server. IEA then subjected these data to a comprehensive process of checking and editing until the data were consistent and comparable. As an example, an item unique to the 2020 administration asked teachers to indicate which grade levels they taught during the current school year. For some of the participating countries, teachers who taught grade 8 in 2018 could only be teaching a certain grade level or higher, due to various reasons, for example, their teaching accreditation, while in another country there was an upper limit or no such limit. This resulted in less or different response options for some countries. These response options were then converted into individual items coded "yes" if the participant indicated they taught the grade level, or "no" if they did not. Therefore, for countries with fewer response options, there were missing items in the data set. These items were added where needed and given a missing code indicating the item was not administered in that country.

5.3.1 Documentation and structure check

For each country, data cleaning began with an exploratory review of its data file structures and data documentation (i.e., national adaptation forms). IEA identified differences between the international and national file structures as some countries made adaptations. For example, Finland and Uruguay added na-

tional variables regarding COVID-19 to their questionnaires, and for some items country-specific response categories were inserted within existing international variables. Once the IEA ensured that each country data file matched the international format, a series of standard data cleaning rules for further processing were applied.

5.3.2 Generation of the ICILS Teacher Panel international and national databases

In order to establish a longitudinal database, each record in a data file has a unique ID number, and the IDs from 2018 were kept and used for the same individuals and schools in 2020. IEA checked all questionnaire data for consistency across the responses given. The ICILS Teacher Panel's international database incorporated all national data files from participating countries, while removing national specific items. The data processing and validation at the international level helped to ensure that (a) information coded in each variable was internationally comparable; (b) national adaptations were reflected appropriately in all variables; (c) all questions relevant to the disruption caused by the COVID-19 pandemic were coded as "not administered" in Denmark; (d) only those records considered as participating (following adjudication) remained in the international database files (individual teachers that were included in the ICILS 2018 Public Use File (PUF) and whom participated in ICILS Teacher Panel); (e) sampling weights were available; and (f) indirect identification of individuals was prevented by applying confidentiality measures, such as scrambling ID variables or removing some personal data variables needed only during field operations and data processing. For the last point, since the present studies' data was combined with ICILS 2018 data, the scrambled IDs from 2018 were retained.

CHAPTER 6

Sample and non-response bias analysis

Diego Cortés, Justin Wild, Yuan-Ling Liaw, Rolf Strietholt & Sabine Meinck

As noted previously, the IEA ICILS Teacher Panel is an extension of the ICILS 2018 teacher survey and therefore built upon the same framework. In contrast to common IEA population-based cross-sectional surveys, data derived for the teacher panel was collected to investigate the changes in teachers' ICT-related practices associated to the COVID-19 global outbreak; rather than to describe population traits.

Nevertheless, this does not downplay the relevance of the teacher panel, as it allows a different set of questions to be explored, which would not be possible to investigate in a cross-sectional setting. This chapter presents a description of the teacher panel sample and explores the potential bias due to panel attrition.

6.1 Sample sizes

The baseline sample of the ICILS Teacher Panel corresponds to the set of schools and teachers participating in ICILS 2018 in Denmark, Finland, and Uruguay. For each participating country, details about the sample design, sample sizes, participation rates, and other characteristics of the original ICLIS 2018 sample and its implementation can be found in the ICILS 2018 Technical Report (Fraillon et al., 2020a).

The first two columns in Table 6.1 describe school participation in the baseline sample (ICILS 2018). Overall, 138, 143, and 121 schools participated in ICILS 2018 in Denmark, Finland, and Uruguay, respectively. Similarly, the third and fourth columns in Table 6.1 describe schools' responses in the Teacher Panel study. Overall, 99, 142, and 118 schools participated in Denmark, Finland, and Uruguay, respectively. Finally, in the last column we show the overall schools' response rate, which is the output of the second and fourth columns.

Table 6.1: Unweighted school participation rate and response rate in the school survey in ICILS 2018 and ICILS Teacher Panel

	ICILS 2018		ICILS Teacher Panel		
	Participating schools (after replacements)	School participation rate (after replacements) (%)	Participating schools	Panel response rate (%)	Overall response rate (%)
Denmark	138	92.0	99	71.7	66.0
Finland	143	97.9	142	99.3	97.3
Uruguay	121	70.3	118	97.5	68.6

Note: The school participation rate in ICILS 2018 is calculated by dividing the number of participating schools (after replacements) by the number of eligible schools in 2018.

A similar set of statistics for teachers' participation is presented in Table 6.2. The first two columns in Table 6.2 describe teacher participation in the baseline sample (ICILS 2018). Overall, 1,118, 1,853, and 1,320 teachers participated in ICILS 2018 in Denmark, Finland, and Uruguay, respectively. Similarly, the third and fourth columns in Table 6.2 describe teachers' response in the Teacher Panel study. Overall, 445, 1,246, and 468 teachers participated in Denmark, Finland, and Uruguay, respectively. Finally, in the last column we show the overall teachers' response rate, which is the output of the second and fourth columns.

Readers and data users are encouraged to acknowledge the possibility of biases in the estimation of statistical parameters induced by the relatively low response of teachers and schools in the Teacher Panel study. In this light, the next section of this chapter investigates whether participation status correlates with observable characteristics.

Table 6.2: Unweighted teacher participation rate and response rate in the teacher survey in ICILS 2018 and ICILS Teacher Panel study

	ICILS 2018		ICILS Teacher Panel		
	Participating teachers (after replacements)	Overall teacher participation rate (after replacements) (%)	Participating teachers	Panel response rate (%)	Overall response rate (%)
Denmark	1,118	77.7	445	39.8	30.9
Finland	1,853	90.3	1,246	67.2	60.7
Uruguay	1,320	53.0	468	35.5	18.8

Note: The computation of the overall teacher participation rate in the teacher survey in ICILS 2018 involves school participation rate in the teacher survey and teacher participation rate before and after replacements. The details of how to calculate overall teacher participation rate in the teacher survey can be found in ICILS 2018 Technical Report Chapter 7 Sampling weights, non-response adjustments, and participation rates (Tieck, 2020). Among the teachers participating in the ICILS Teacher Panel, 436 teachers in Denmark and 1,156 teachers in Finland taught at the same school in 2018 and 2020. It is relatively common for teachers in Uruguay to change schools between school years. The information of teacher changing school status was not collected in Uruguay.

6.2 Non-response bias analysis

This section uses the rich set of information available from ICILS 2018 to explore the potential for biases introduced by the non-participation of schools or teachers. That is, it explores whether schools or teachers participating in the panel differ systematically to those that did not participate in a set of characteristics observed in 2018. The variables used in this section come from the ICILS 2018 questionnaires. Some variables capture a response to a single item, while other variables are derived scales reflecting a theoretical construct. For details about how these variables are constructed, see the ICILS 2018 Technical Report (Fraillon et al., 2020a). Importantly, we focus on two type of variables. First, we focus on background characteristics to explore the hypothesis that personal traits or individual characteristics associate with the likelihood of participation in the panel. Second, we focus on variables capturing ICT-related behaviors and attitudes, which are central to this report.

Table 6.3 presents a non-response bias analysis among schools participating in the baseline sample. For each country, the table presents the weighted mean of school-level derived variables for schools not participating in the panel and those that did (columns 1 and 2). Column (3) shows the mean difference between these two groups, and column (4) the standard error of the difference. Standard errors are derived using the ***Jackknife repeated replication method*** for variance estimation (Fraillon et al., 2020a). Differences that are statistically significant at a 95% level are marked with an asterisk.

Across the three participating countries, Table 6.3 shows no systematic difference between schools participating in the panel study and those that did not. Overall, mean differences across all variables are small in size and not statistically significant. The only exception is the scale reflecting the availability of ICT resources in schools ($ICTRES$) for Uruguay, in which schools participating in the panel study score about four points higher in the scale than those that did not. This is about 40% of the estimated standard deviation in the population.[1]

1 Research or policy analysts doing secondary analyses with the data from the Teacher Panel are encouraged to explore the potential for biases due to non-response in the context of their research question.

Table 6.3: Mean difference in observed characteristics at the school level

	Denmark				Finland				Uruguay			
	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)
P_ICTUSE	50.80	50.84	-0.03	1.92	49.18	49.48	-0.30	2.28	49.72	49.09	0.62	2.69
P_VWICT	48.41	50.82	-2.41	1.79	52.94	52.02	0.92	3.28	50.91	48.96	1.95	2.15
P_EXPLRN	52.81	54.14	-1.34	1.24	53.89	50.70	3.18	3.03	47.96	48.39	-0.43	1.41
P_PRIORH	48.25	46.12	2.13	2.06	55.83	52.74	3.09	3.62	52.28	52.27	0.02	2.01
P_PRIORS	46.24	46.87	-0.63	1.44	48.04	49.96	-1.92	1.98	51.94	55.30	-3.36	2.48
C_ICTRES	54.70	56.96	-2.27	2.40	60.94	58.66	2.28	2.84	50.06	54.90	-4.84*	2.39
C_HINRES	44.59	41.01	3.57	1.90	48.40	50.46	-2.07	1.73	51.47	51.29	0.19	1.91
C_HINPED	46.96	45.35	1.61	2.21	53.29	53.15	0.14	1.92	49.71	50.01	-0.30	1.91

*Note: Variables reflecting principal's responses are indicated by a prefix 'P', while variables reflecting responses from ICT coordinators are indicated by a prefix 'C'. P_ICTUSE = principals' use of ICT for general school-related activities; P_VWICT = view on using ICT for educational outcomes; P_EXPLRN = ICT use expected of teachers; P_PRIORH = priorities for increased ICT resources; P_PRIORS = priorities for increased ICT professional learning resources; C_ICTRES = availability of ICT resources at school; C_HINRES = computer resource hindrances on the use of ICT in teaching and learning; C_HINPED = pedagogical resource hindrances to the use of ICT in teaching and learning. *$p < .05$.*

Similarly, Table 6.4 presents a non-response bias analysis among teachers participating in the baseline sample (ICILS 2018). For each country, the table presents the weighted mean of teachers' responses to a single item or the weighted mean of a derived scale for teachers not participating in the panel study (column (1)) and those that did participate (column (2)). Column (3) shows the mean difference between these two groups, and column (4) the standard error of the difference. Standard errors are derived using the Jackknife repeated replication method for variance estimation (Fraillon et al., 2020a). Differences that are statistically significant at a 95% level are marked with an asterisk.

Overall, Table 6.4 reports no systematic difference between teachers participating in the panel and those that did not in Denmark and Uruguay. In Finland, the teacher's age shows statistically significant association with participation status. This might reflect the change in the age structure of the teacher population between 2018 and 2020. For example, from the total number of teachers not participating in the panel, about 14% were above 63 years old in 2018, while only 3% of those participating in the panel study were above 63 years old in 2018. It is plausible that this large difference reflects that teachers retire around this age and were not able to participate in 2020. Although the differences in age are smaller in the other two countries, this may illustrate a general problem of panel studies: If participants drop out of a study due to age, this has consequences for the target population. In the ICILS Teacher Panel, the two surveys are only two years apart, so we would only acknowledge this problem here as a limitation, and not over interpret it. Finally, in Finland there is a small but statistically significant difference in teachers' response to the question "Approximately how long have you been using ICT for the following purposes: (a) during lessons, and (b) preparing lessons" (variables: $IT2G05A$ and $IT2G05B$, respectively). Teachers participating in the panel study are, on average, more likely to have used ICT longer for these purposes. These differences account for about 20% of one (weighted) standard deviation of the variable in the baseline sample.[2]

The non-response analysis reveals only a few statistically significant differences with respect to the observed variables in all three countries. Following Cohen's (1988) classical classification of effect sizes, even these few significant differences may be considered small. However, although the differences are small, they may limit the generalizability of the results. In the next chapter, we will explain how we attempt to account for this problem by adjusting the weights.

2 Similar as above, research or policy analysts doing secondary analyses with the data from the Teacher Panel study are encouraged to explore the potential for biases due to non-response in the context of their research question.

Table 6.4: Mean difference in observed characteristics at the teacher level

	Denmark				Finland				Uruguay			
	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)	$Part_0$ (1)	$Part_1$ (2)	Diff (3)	S.E. (4)
Gender	0.57	0.62	-0.05	0.03	0.72	0.72	0.01	0.03	0.69	0.72	-0.03	0.03
AGE_27	0.08	0.07	0.01	0.01	0.09	0.06	0.03*	0.01	0.19	0.16	0.04	0.03
AGE_35	0.28	0.22	0.05	0.04	0.29	0.24	0.05*	0.02	0.33	0.34	-0.01	0.04
AGE_55	0.23	0.23	-0.01	0.03	0.23	0.33	-0.10*	0.02	0.16	0.19	-0.03	0.03
AGE_63	0.12	0.09	0.03	0.02	0.14	0.03	0.11*	0.02	0.04	0.02	0.02	0.01
IT2G04_2	0.01	0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.17	0.20	-0.03	0.02
IT2G05A	3.66	3.73	-0.07	0.04	3.37	3.55	-0.18*	0.04	3.01	3.13	-0.12	0.07
IT2G05B	3.71	3.78	-0.08	0.04	3.57	3.70	-0.12*	0.03	3.33	3.50	-0.17*	0.06
T_ICTEFF	53.42	52.92	0.51	0.68	51.31	50.84	0.46	0.51	49.56	51.29	-1.73*	0.61
T_ICTEMP	50.12	51.88	-1.76*	0.71	43.09	43.57	-0.47	0.54	48.01	49.18	-1.17	0.71
T_CLASACT	57.61	59.32	-1.72*	0.63	47.73	47.26	0.47	0.43	49.12	49.92	-0.80	0.70
T_ICTPRAC	53.33	54.14	-0.81	0.77	47.62	47.72	-0.09	0.41	46.28	49.02	-2.74*	0.72
T_USETOOL	54.15	53.88	0.28	0.56	50.10	50.58	-0.48	0.39	47.88	48.66	-0.79	0.62
T_USEUTIL	50.58	50.70	-0.12	0.61	47.57	48.30	-0.73	0.47	44.67	45.94	-1.27*	0.61
T_CODEMP	47.37	47.29	0.08	0.84	43.95	44.03	-0.08	0.37	49.74	50.09	-0.35	0.75
T_RESRC	51.62	52.00	-0.38	0.80	48.83	48.75	0.07	0.50	45.16	44.84	0.32	0.60
T_COLICT	49.46	49.26	0.20	0.85	48.10	48.99	-0.89	0.54	51.26	52.93	-1.67*	0.60
T_PROFSTR	49.22	49.10	0.12	0.83	49.06	49.87	-0.81	0.42	49.24	51.65	-2.41*	0.68
T_VWNEG	48.34	48.39	-0.05	0.72	50.32	50.29	0.02	0.41	45.60	44.69	0.92	0.94
T_VWPOS	48.05	48.32	-0.27	0.66	45.68	45.25	0.44	0.42	49.11	49.55	-0.44	1.00

*Note: Gender = gender of teacher; AGE_27 = age of teachers between 25-29; AGE_35 = age of teachers between 30-39; AGE_55 = age of teachers between 50-49; AGE_63 = age of teachers above 60; IT2G04_2 = Teacher taught in this and another school; IT2G05A = experience with ICT use during lessons; IT2G05B = experience with ICT use for preparing lessons; T_ICTEFF = teachers ICT self-efficacy; T_ICTEMP = emphasis on ICT capabilities in class; T_CLASACT = use of ICT for classroom activities; T_ICTPRAC = use of ICT for teaching practices in class; T_USETOOL = use of digital learning tools; T_USEUTIL = use of general utility software; T_CODEMP = teacher emphasis of teaching coding tasks in class; T_RESRC = availability of computer resources at school; T_COLICT = collaboration between teachers in using ICT; T_PROFSTR = teacher participation in structured learning professional development related to ICT; T_VWNEG = negative views on using ICT in teaching and learning; T_VWPOS = positive views on using ICT in teaching and learning. *$p < .05$.*

CHAPTER 7

Weights and variance estimation

Diego Cortés, Yuan-Ling Liaw, Rolf Strietholt, Justin Wild, & Sabine Meinck

7.1 Point estimates

7.1.1 Weighted estimation

When looking at the sampling of ICILS 2018 and the Teacher Panel study, it is important to note that there are different selection probabilities regarding teachers' selection to participate in ICILS 2018. Therefore, the use of sampling weights is recommended for estimating population parameters when using data derived from ICILS 2018 (Fraillon et al., 2020a). The underlying reason for this is twofold. First, the probability of participation in the Teacher Panel for teacher t is directly related to its probability of participation in ICILS 2018. This is easy to see, as teacher t participates in the Teacher Panel study if and only if he or she participated in ICILS 2018.

The second reason, and probably the most important one, is that survey outcomes are potentially endogenous to the probability of participation in ICILS 2018 (and therefore also in the Teacher Panel study). This is because selection probabilities vary systematically by school size and across strata when subpopulations were oversampled. For ICILS 2018, schools were sampled with a probability proportional to their size, which implies that larger schools had a larger probability to be sampled. Moreover, to increase precision in the estimation, oversampling of schools and teachers was performed across certain subpopulations (strata). This means that schools and teachers with certain attributes were more likely to be part of the original sample. The use of sampling weights corrects the biases introduced by this potentially endogenous sampling mechanism. That is, weighted estimation of parameters, accounts for the underlying correlation between selection probabilities and survey outcomes.

7.1.2 Construction of panel weights

Attached to each participating unit in the ICILS Teacher Panel databases, there is an estimation weight. For the teacher-level database this variable is labeled $TOTWGTT$ and for the school-level database it is labeled $TOTWGTC$. Estimation weights are constructed as the product of the baseline weight and a panel adjustment factor. The baseline weight represents the total weight of each unit as reported by ICILS 2018. That is, the total weight for school s represents its probability of inclusion in the ICILS 2018 sample, adjusted by a factor reflecting non-participation of other sampled schools. Similarly, for teacher t, in school s, its baseline weight represents the probability of inclusion in the baseline sample, adjusted for non-participation of other units. Details about the construction of sampling weights for ICILS 2018 can be found in ICILS 2018 Technical report, chapter 7: Sampling weights, non-response adjustments, and participation rates (Fraillon et al., 2020a).

The following procedure was applied to adjust the estimation weight to account for panel attrition in the ICILS Teacher Panel. In a first step, the probability of participation in the panel for school s or teacher t was predicted as a function of observed characteristics in ICILS 2018. That is, to adjust the school-level estimation weight, an indicator capturing participation in the panel of school s was regressed on the set of observables listed in Table 6.3 using a weighted logistic regression. Similarly, to adjust the teacher-level estimation weight, an indicator capturing participation in the Teacher Panel study of teacher t was regressed on the set of observables listed in Table 6.4 using a weighted logistic regression.[1] Estimation weights, as reported in ICILS 2018, were used to account for the potentially endogenous sampling mech-

1 As the percentage of missing values for any explanatory variable in the model was low (see Table 7.1 for schools and Table 7.2 for teachers), all missing values were converted to the appropriate measure of the central tendency for the variable: mode for nominal variables, median for ordinal variables, and mean for continuous variables. Predicted probabilities do not change substantially if alternative observations with missing values are dropped.

Table 7.1: Percentages of missing values for school-level variables

	Denmark	Finland	Uruguay
II2G01	11.2	2.8	22.8
II2G02A	13.3	2.8	21.5
II2G02B	13.3	2.8	21.5
II2G02C	13.3	2.8	20.9
II2G02D	13.3	2.8	20.9
P_ICTUSE	2.1	2.1	14.6
P_ICTCOM	2.1	2.1	14.6
P_VWICT	3.5	3.5	21.5
P_EXPLRN	4.9	2.8	21.5
P_EXPTCH	4.9	2.8	21.5
P_PRIORH	4.9	2.8	22.2
P_PRIORS	4.9	2.8	22.2
C_ICTRES	11.9	2.1	19.6
C_HINRES	14.0	2.1	22.2
C_HINPED	14.0	2.8	23.4

Note: Variables reflecting principals' responses are indicated by a prefix 'P', while variables reflecting responses from ICT coordinators are indicated by a prefix 'C' or 'II". II2G01 = ICT-coordinator held the position formally, informally, or the respondent was not a ICT-coordinator but answered as the school principal or his/her designate; II2G02A = ICT-coordinator taught ICT courses to students; II2G02B = ICT-coordinator taught other subjects (not related to learning about ICT) to students; II2G02C = ICT-coordinator didn't have any teaching duties for students.; II2G02D = ICT-coordinator taught ICT courses to, or conducted workshops for, teachers and other; P_ICTUSE = principals' use of ICT for general school-related activities; P_ICTCOM = principals' use of ICT for school-related communication activities; P_VWICT = view on using ICT for educational outcomes; P_EXPLRN = ICT use expected of teachers; P_EXPTCH = expectations for teacher collaboration using ICT; P_PRIORH = priorities for increased ICT resources; P_PRIORS = priorities of increased ICT professional learning resources; C_ICTRES = availability of ICT resources at school; C_HINRES = computer resource hindrances on the use of ICT in teaching and learning; C_HINPED = pedagogical resource hindrances on the use of ICT in teaching and learning.

anism implemented in ICILS 2018 (see above). The logistic regression to predict school s's participation had the following form:[2]

$$logit(PART_s) = \alpha + z_s'\beta + u_s \tag{7.1}$$

while the logistic regression to predict teacher t's participation had the following form:

$$logit(PART_t) = \alpha + x_t'\gamma + u_t \tag{7.2}$$

where $PART_s$ ($part_T$) is a dummy indicating whether school s (teacher t) participates in the panel and z_s (x_t) is a vector of observed characteristics for school s (teacher t).

The vector of estimated coefficients in each logistic regression model ($\hat{\beta}$ in equation 7.1 for schools, and $\hat{\gamma}$ in equation 7.2 for teachers was used to estimate the probability of school s and teacher t from the baseline

2 The results derived from these logistic regressions can be made available upon request.

Table 7.2: Percentages of missing values for teacher-level variables

	Denmark	Finland	Uruguay
T_SEX	0.0	0.0	0.0
T_AGE	0.1	0.2	0.5
IT2G04	0.4	0.4	1.4
IT2G05A	0.7	0.4	2.7
IT2G05B	3.4	1.9	4.8
T_ICTEFF	0.8	0.1	3.0
T_ICTEMP	0.9	0.6	3.6
T_CLASACT	1.8	6.1	8.5
T_ICTPRAC	3.0	8.4	12.1
T_USETOOL	2.0	1.4	5.7
T_USEUTIL	1.9	1.4	5.9
T_CODEMP	2.3	1.8	6.1
T_RESRC	2.1	1.7	6.4
T_COLICT	2.2	1.7	6.5
T_PROFSTR	2.1	1.6	6.2
T_VWNEG	2.6	1.8	6.4
T_VWPOS	2.7	1.8	6.7

Note: T_SEX = gender of teacher; T_AGE = age of teachers; IT2G04 = allocation of teachers' staff time for the sampled school; IT2G05A = experience with ICT use during lessons; IT2G05B = experience with ICT use for preparing lessons; T_ICTEFF = teachers' ICT self-efficacy; T_ICTEMP = emphasis on ICT capabilities in class; T_CLASACT = use of ICT for classroom activities; T_ICTPRAC = use of ICT for teaching practices in class; T_USETOOL = use of digital learning tools; T_USEUTIL = use of general utility software; T_CODEMP = teachers' emphasis of teaching coding tasks in class; T_RESRC = availability of computer resources at school; T_COLICT = collaboration between teachers in using ICT; T_PROFSTR = teachers' participation in structured learning professional development related to ICT; T_VWNEG = negative views on using ICT in teaching and learning; T_VWPOS = positive views on using ICT in teaching and learning.

sample to participate in the panel. To avoid a large variation in final estimation weights among participating units in the panel, predicted probabilities were trimmed as recommended by Van de Kerckhove, Mohadjer, & Krenzke (2014). That is, the interquartile range (IQR) was used to calculate cut-off points for school and teacher-level estimation weights for each country c:

$$threshold_{cs} = Q_{3,s} + 1.5 * (Q_{3,s} - IQR_s) \tag{7.3}$$

and

$$threshold_{ct} = Q_{3,t} + 1.5 * (Q_{3,t} - IQR_t) \tag{7.4}$$

where $Q_{3,s}$ ($Q_{3,t}$) represent the third quartile of the predicted probability distribution among those schools (teachers) participating. The described procedure and thresholds affected the weights of only a few teachers and schools. For Finland, the weights of five schools and nine teachers were trimmed and for Uruguay, the weights of only two teachers were trimmed. All other weights remained unchanged.

After trimming, the inverse of the estimated probability of participation for school s or teacher t was used as a weight adjustment for the panel ($WGTADJ\_PANEL_s$ and $WGTADJ\_PANEL_t$, respectively). School and teacher-level estimation weights for the panel study were then created as products of the

estimation weights created for ICILS 2018 ($Old\_TOTWGTC_s$ and $Old\_TOTWGTT_T$) and the trimmed weight adjustments:

$$TOTWGTC_s^* = WGTADJ\_PANEL_s \times Old\_TOTWGTC_s \tag{7.5}$$

and;

$$TOTWGTT_t^* = WGTADJ\_PANEL_t \times Old\_TOTWGTT_t \tag{7.6}$$

Finally, for each participating country, the school-level and teacher-level estimation weights adjusted for panel attrition, were multiplied by a constant ($WGTFAC\_PANEL_{c,s}$ and $WGTFAC\_PANEL_{c,t}$, respectively) so that the sum of these weights equals the population size estimated in ICILS 2018. That is:

$$TOTWGTC_s = TOTWGTC_s^* \times WGTFAC\_PANEL_{c,s} \tag{7.7}$$

and;

$$TOTWGTT_t = TOTWGTT_t^* \times WGTFAC\_PANEL_{c,t} \tag{7.8}$$

where,

$$WGTFAC\_PANEL_{c,s} = \frac{\sum_{s=1}^{S} Old\_TOTWGTC_s}{\sum_{s=1}^{S} TOTWGTC_s^*} \tag{7.9}$$

and;

$$WGTFAC\_PANEL_{c,t} = \frac{\sum_{t=1}^{T} Old\_TOTWGTT_t}{\sum_{t=1}^{N} TOTWGTT_t^*} \tag{7.10}$$

$Old\_TOTWGTC_s$, $WGTADJ\_PANEL_s$, $WGTFAC\_PANEL_{c,s}$, and $TOTWGTC_s$ are attached to the school-level database; and, $Old\_TOTWGTT_t$, $WGTADJ\_PANEL_t$, $WGTFAC\_PANEL_c$, and $TOTWGTT_t$ are attached to the teacher-level database. Figure 7.1 shows a scatterplot for each participating country with the original ICILS 2018 school estimation weight ($Old\_TOTWGTS_s$) on the x-axis and the final estimation weight for the teacher panel ($TOTWGTS_s$) on the y-axis. Figure 7.2 shows a similar scatterplot but using teacher-level estimation weights. Overall, the figures point to a positive and consistent correlation between the original and panel-adjusted set of weights, for both the teacher and school populations.

Figure 7.1: A comparison of school-level estimation weights for 2018 and 2020

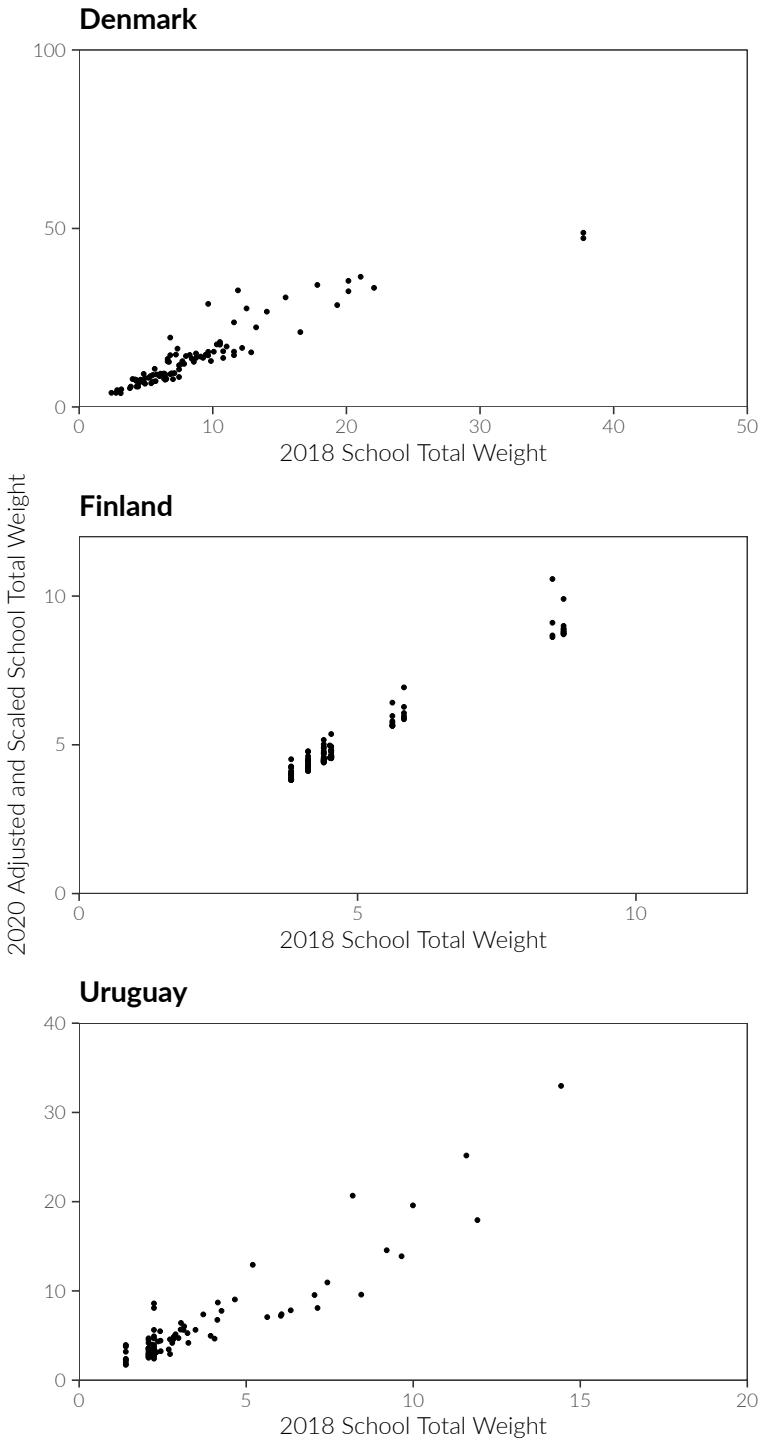
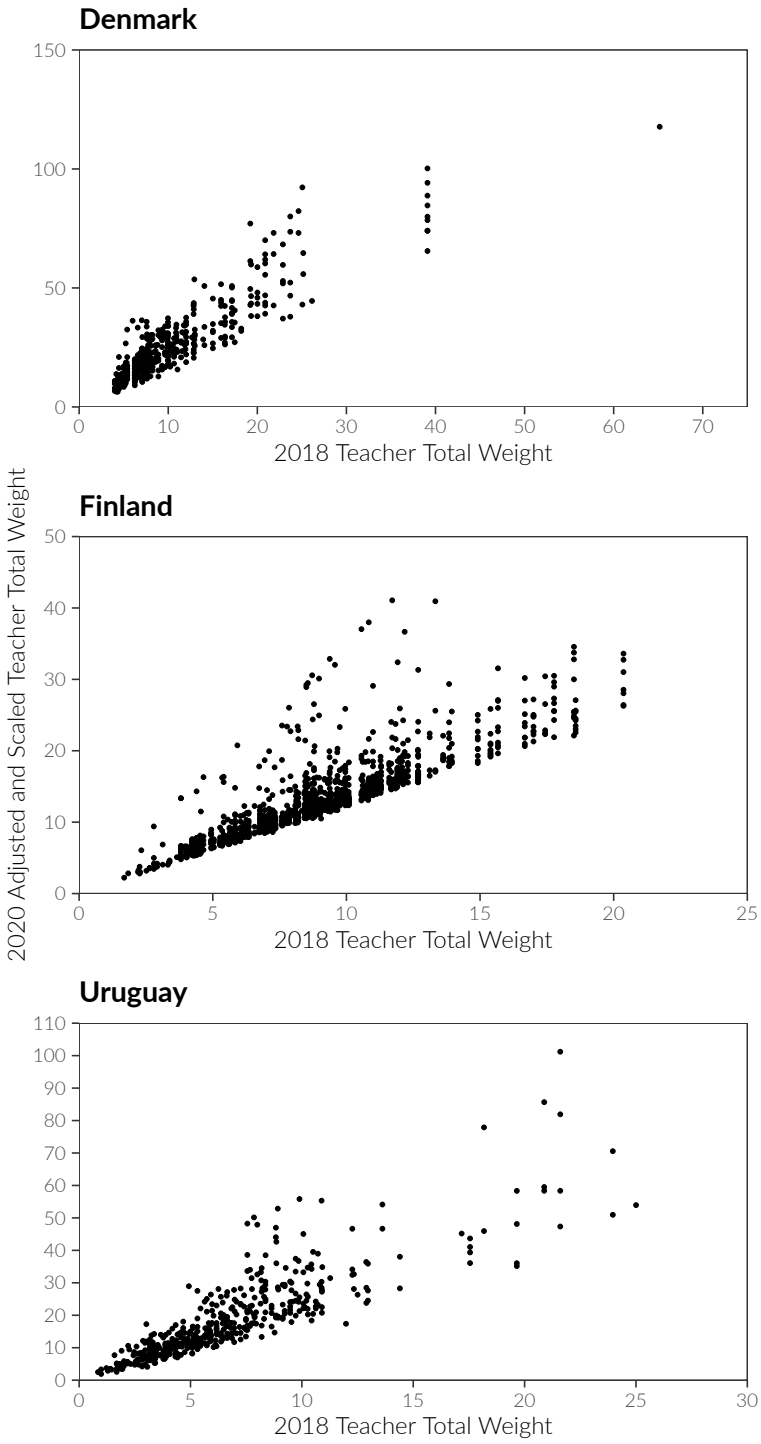


Figure 7.2: A comparison of teacher-level estimation weights for 2018 and 2020



Finally, Table 7.3 and Table 7.4 report some statistics on the original estimation weights for ICILS 2018 and the adjusted estimation weights for attrition in the Teacher Panel, respectively. Reassuringly, the distribution of estimation weights is similar for the original and the panel-adjusted set of weights, in both the teacher and the school populations.

Table 7.3: Descriptive statistics of teacher-level estimation weights

	Denmark		Finland		Uruguay	
	Original	Panel adjusted	Original	Panel adjusted	Original	Panel adjusted
Minimum	4.00	6.35	1.68	2.22	0.85	1.91
1st Quartile	6.25	14.58	6.26	9.03	3.88	10.17
Median	8.00	21.31	8.56	12.09	5.90	14.66
Mean	10.55	25.99	8.77	13.02	6.72	18.72
3rd Quartile	12.01	30.98	10.71	15.73	8.36	23.93
Maximum	65.16	117.13	20.37	41.00	25.00	101.09

Table 7.4: Descriptive statistics of school-level estimation weights

	Denmark		Finland		Uruguay	
	Original	Panel adjusted	Original	Panel adjusted	Original	Panel adjusted
Minimum	2.41	3.83	3.81	3.81	1.40	1.72
1st Quartile	5.52	7.85	4.11	4.20	2.08	2.99
Median	7.30	12.58	4.39	4.53	2.24	4.08
Mean	8.98	14.31	4.81	5.02	3.43	5.77
3rd Quartile	10.53	16.08	4.53	4.91	3.43	6.32
Maximum	37.73	48.60	8.70	10.57	14.43	32.97

7.2 Example of data analysis

Overall, there are three types of statistical analyses presented in this report. First, we present descriptive statistics within each data collection. That is, we present parameters that characterize the distribution of the variable or characteristic of interest within 2018 and 2020, separately.

Secondly, in some chapters, we present estimated parameters that represent the change of a variable or characteristic of interest between the two data collections. For example, a central analysis in this report is the investigation of how the educational opportunity gap between teachers in socioeconomically advantaged and disadvantaged schools changed between 2018 and 2020. To measure the school's socioeconomic status, we use the variable ***national index of socioeconomic background*** which was measured in 2018 and combines student level information from three different variables: ***highest occupational status of parents***, ***highest educational level of parents*** and ***number of books at home***. The index was aggregated at the school-level, and the median value within each country was used as a cut-off point to group the schools into low and high socioeconomic status. A school labeled with a low (high) socioeconomic status in 2018 was labeled with a low (high) socioeconomic status in 2020. The differences in teacher responses (percentages of responses in a certain category) to the variables of interest were computed for both time points for the two groups of teachers. For the gaps in 2018 or the gaps in 2020, we calculated the percentages of teachers who reported to a certain category in high socioeconomic status schools minus the percentages of teachers who reported to the same category in low socioeconomic status schools. To examine if the difference between the two groups changes across time, we used a regression model with a difference-in-difference specification. Specifically, we ran linear regressions with the following form:

$$y_{ts} = \beta_0 + \beta_1 \times lowSES_t + \beta_2 \times 2020 + \beta_3 \times lowSES_t \times 2020 + \epsilon_{ts} \tag{7.11}$$

where $lowSES_t$ equals one if teacher t teaches in a school labeled as low socioeconomic status, otherwise zero. The variable $\mathbf{2020}$ equals one if the observation is measured in 2020, otherwise zero. Finally, the coefficient of interest is β_3 and captures how the difference in a specific teacher characteristic changed over time between teachers within high and low socioeconomic status schools. The next section describes how standard errors for the estimated parameters were computed.

Finally, the tetrachoric correlation is used to measure the association before and after the outbreak of COVID-19 on the ICT related issues that were reported from teachers, principals, and ICT-coordinators. The tetrachoric correlation coefficient, r_{tet}, is obtained from a 2 x 2 contingency table and estimates what the correlation would be if measured on a continuous scale (Pearson, 1900). Many of the scales in ICILS were constructed to measure individuals' latent traits by developing several items with some response categories (e.g., four response options from "Strongly disagree" to "Strongly agree" are used to measure the level of agreement.) As the item responses were further dichotomized in this report, and we focused on the percentages of a selected category in the years 2018 and 2020, the tetrachoric correlation provided the association between the two studies.

7.3 Sampling variance of an estimator

The variance of an estimate Ω reflects the uncertainty associated to it due to the random process generating the data used to estimate it. The application of probabilistic samples in international large-scale assessments (ILSAs) in education means that a key random component of the data generating process in these surveys is the sampling mechanism through which participating units were selected to participate. This implies that the variance of Ω is a compound of the uncertainty in it due to the sampling mechanism (***sampling variance***) and other potential sources of uncertainty. In the context of the ICILS Teacher Panel, the sampling variance of Ω plays a central role, and therefore it is necessary for statistical inference when using this data.

To estimate the sampling variance of Ω we use in this report, the so-called Jackknife Repeated Replication method for variance estimation. This methodology accounts for the sampling design typically implemented in ILSAs and is relatively straightforward to implement. Since the ICILS Teacher Panel is an extension of the ICILS 2018 survey, we use the same design for variance estimation as featured in ICILS 2018. That is, for each participating country, we compute a set of 75 replicate weights and estimate the sampling variance of Ω as follows;

$$Var_{\Omega} = \sum_{i=1}^{75} (\Omega_i - \Omega)^2 \tag{7.12}$$

where, Ω is estimated using the estimation weights adjusted for panel attrition (see above), and Ω_i is estimated using the ith replicate weight ($i = 1, ..., 75$). A set of 75 replicate weights is attached to the teacher and school-level databases. These are constructed using the same design for variance estimation as in ICILS 2018. Which means, the original variance zones and replication indicators were retained, but the estimation weight was adjusted for panel attrition as described above. Finally, in the context of the ICILS Teacher Panel, the standard error of the estimated parameter Ω is the standard deviation of its sampling variance:

$$SE\left(\Omega\right) = \sqrt{Var_{\Omega}} \tag{7.13}$$

The reader is encouraged to consult the chapter on "Reporting of ICILS 2018 results" of the ICILS 2018 Technical Report for details on how variance zones and replication indicators were originally defined (Fraillon et al., 2020a).

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APPENDIX A

Number of respondents by item

Table A.1: Number of teachers responding to each item

Variable	Description	Denmark	Finland	Uruguay
T_EXLES	During lessons	438	1242	440
T_EXPREP	Preparing lessons	418	1215	422
IT2G06A	At school when teaching	439	1241	441
IT2G06B	At school for other work-related purposes	437	1237	430
IT2G06C	Outside school for work-related purposes	436	1235	436
IT2G06D	Outside school for non-work-related purposes	437	1235	423
IT2G07A	Find useful teaching resources on the Internet	433	1241	442
IT2G07B	Contribute to a discussion forum/user group on the Internet	432	1234	431
IT2G07C	Produce presentations with simple animation functions	431	1239	437
IT2G07D	Use the Internet for online purchases and payments	433	1240	430
IT2G07E	Prepare lessons that involve the use of ICT by students	428	1236	435
IT2G07F	Using a spreadsheet program for keeping records or analyzing data	433	1237	431
IT2G07G	Assess student learning	432	1237	434
IT2G07H	Collaborate with others using shared resources	430	1234	434
IT2G07I	Use a learning management system	431	1237	437
IT2G09A	To access information efficiently	428	1206	417
IT2G09B	To display information for a given audience/purpose	425	1202	406
IT2G09C	To evaluate the credibility of digital information	428	1197	412
IT2G09D	To share digital information with others	422	1194	409
IT2G09E	To use computer software to construct digital work products	424	1197	404
IT2G09F	To provide digital feedback on the work of other classmates	427	1200	408
IT2G09G	To explore a range of digital resources when searching for info.	424	1198	413
IT2G09H	To provide references for digital information sources	425	1200	409
IT2G09I	To understand the consequences of making info. available online	426	1201	406
IT2G10A*	Work on extended projects (i.e., lasting over a week)	364	687	237
IT2G10B*	Work on short assignments (i.e., within one week)	415	923	347
IT2G10C*	Explain and discuss ideas with other students	395	853	283
IT2G10D*	Submit completed work for assessment	406	990	344
IT2G10E*	Work individually on learning materials at their own pace	404	996	327
IT2G10F*	Undertake open-ended investigations or field work	341	784	226
IT2G10G*	Reflect on their learning experiences (e.g., by using a log)	325	670	200
IT2G10H*	Communicate with students in other schools on projects	383	671	223
IT2G10I*	Plan a sequence of learning activities for themselves	294	471	192
IT2G10J*	Analyze data	356	849	249
IT2G10K*	Evaluate information resulting from a search	386	866	284
IT2G10L*	Collect data for a project	397	963	295
IT2G10M*	Create visual products or videos	404	877	277
IT2G10N*	Share products with other students	401	848	279
IT2G11A+	Presentation of information through direct class instruction	411	1103	312
IT2G11B+	Provision of enrichment support to individual students or small groups	395	790	307

Variable	Description	Denmark	Finland	Uruguay
IT2G11C+	Support of student-led whole-class discussions and presentations	389	837	263
IT2G11D+	Assessment of students' learning through tests	389	797	331
IT2G11E+	Provision of feedback to students on their work	402	947	317
IT2G11F+	Reinforcement of learning of skills through repetition of examples	377	916	318
IT2G11G+	Support of collaboration among students	387	866	335
IT2G11H+	Mediation of communication between students and experts	262	531	190
IT2G11I+	Communication with parents about students' learning	385	1109	202
IT2G11J+	Support of inquiry learning	398	902	299
IT2G12A	Practice programs/apps where you ask students questions	412	1188	367
IT2G12B	Digital learning games	410	1182	364
IT2G12G	Concept mapping software (e.g., [Inspiration®], [Webspiration®])	409	1180	361
IT2G12H	Simulations and modelling software (e.g., [NetLogo])	410	1179	359
IT2G12I	A learning management system (e.g., [Edmodo], [Blackboard])	409	1186	366
IT2G12K	Collaborative software (e.g., [Google Docs®], [Onenote])	409	1175	361
IT2G12M	Interactive digital learning resources (e.g., learning objects)	410	1179	360
IT2G12N	Graphing or drawing software	412	1176	365
IT2G12O	e-portfolios (e.g., [VoiceThread])	407	1172	364
IT2G12Q	Social media (e.g., [Facebook, Twitter])	412	1182	364
IT2G12C	Word-processing software (e.g., [Microsoft Word®])	408	1176	362
IT2G12D	Presentation software (e.g., [Microsoft PowerPoint®])	408	1179	359
IT2G12E	Spreadsheets (e.g., [Microsoft Excel®])	410	1167	357
IT2G12F	Video and photo software for capture and editing (e.g., iMovie)	410	1179	366
IT2G12J	Communication software (e.g., email, direct messaging, Skype)	410	1180	359
IT2G12L	Computer-based information resources (e.g., websites, wikis)	411	1177	359
IT2G12P	Digital contents linked with textbooks	411	1179	362
IT2G13A	To display information in different ways	408	1179	365
IT2G13B	To break a complex process into smaller parts	406	1173	364
IT2G13C	To understand diagrams that describe real-world problems	404	1169	358
IT2G13D	To plan tasks by setting out the steps needed to complete them	405	1175	360
IT2G13E	To use tools making diagrams that help solve problems	407	1173	359
IT2G13F	To use simulations to understand or solve real-world problems	405	1176	362
IT2G13G	To make flow diagrams to show the different parts of a process	404	1173	361
IT2G13H	To record and evaluate data to understand and solve a problem	404	1171	363
IT2G13I	To use real-world data to review and revise solutions to problems	406	1166	363
IT2G14A	ICT is considered a priority for use in teaching	409	1211	371
IT2G14B	My school has sufficient ICT equipment (e.g. computers)	409	1206	372
IT2G14C	The computer equipment in our school is up-to-date	406	1203	368
IT2G14D	My school has access to sufficient digital learning resources	409	1201	367
IT2G14E	My school has good connectivity (e.g., fast speed) to the Internet	409	1207	370
IT2G14F	There is enough time to prepare lessons that incorporate ICT	408	1204	369
IT2G14G	There is sufficient opportunity for me to develop expertise in ICT	408	1207	366
IT2G14H	There is sufficient technical support to maintain ICT resources	406	1207	371
IT2G15A	I work with other teachers on improving the use of ICT in class	409	1206	373
IT2G15B	I collaborate with colleagues to develop ICT-based lessons	408	1206	370
IT2G15C	I observe how other teachers use ICT in teaching	409	1206	370
IT2G15D	I discuss with other teachers how to use ICT in teaching topics	406	1202	368
IT2G15E	I share ICT-based resources with other teachers in my school	409	1206	371

Variable	Description	Denmark	Finland	Uruguay
IT2G18A	Impedes concept formation by students	405	1191	368
IT2G18D	Results in students copying material from Internet sources	403	1202	371
IT2G18F	Distracts students from learning	400	1197	369
IT2G18G	Results in poorer written expression among students	401	1195	364
IT2G18H	Results in poorer calculation and estimation skills among students	395	1172	363
IT2G18I	Limits the amount of personal communication among students	400	1192	367
IT2G18B	Helps students develop greater interest in learning	405	1200	372
IT2G18C	Helps students to work at a level appropriate to their learning needs	401	1187	371
IT2G18E	Helps students develop problem-solving skills	401	1192	367
IT2G18J	Enables students to collaborate more effectively	402	1193	360
IT2G18K	Helps students develop skills in planning/self-regulation of work	399	1190	365
IT2G18L	Improves academic performance of students	402	1178	366
IT2G18M	Enables students to access better sources of information	403	1199	368

*Note: *In IT2G10A-IT2G10N, teachers were asked to provide information about whether their students engaged in a set range of activities, and how often they used ICT as part of these activities; data from teachers who indicated that their students had not engaged in each of these activities ("I do not use this practice with the reference class") were treated as missing values and were not included. +In IT2G11A-IT2G11J, teachers were asked to indicate how often they use ICT for different practices related to teaching of the reference class; teachers who indicated that they did not use this practice with the reference class ("I do not use this practice with the reference class") were treated as missing values and were not included.*

Table A.2: Number of school principals responding to each item

Variable	Description	Denmark	Finland	Uruguay
IP2G02A	Search for information on the internet or school network	79	132	57
IP2G02B	Provide info. about an educational issue through a website	79	132	56
IP2G02C	Look up records in a database (e.g., in a student information system)	79	131	57
IP2G02D	Maintain, organize and analyze data (e.g., with a spreadsheet)	78	130	57
IP2G02E	Prepare presentations	79	132	57
IP2G02J	Work with a learning management system (e.g., [Moodle])	79	131	55
IP2G02K	Use social media to communicate about school-related activities	79	132	57
IP2G02L	Management of staff (e.g. scheduling, prof. development)	79	131	57
IP2G02M	Preparing the curriculum	79	130	56
IP2G02N	School financial management	79	131	57
IP2G02F	Communicate with teachers in your school	79	132	57
IP2G02G	Communicate with education authorities	79	132	57
IP2G02H	Communicate with principals and senior staff in other schools	79	131	56
IP2G02I	Communicate with parents	79	132	57
IP2G09A	Develop students' basic computer skills (e.g., internet use, email, etc.)	69	129	46
IP2G09B	Develop students' skills in using ICT for collaboration with others	69	130	45
IP2G09C	Use ICT for facilitating students' responsibility for their learning	68	129	46
IP2G09D	Use ICT to augment and improve students' learning	68	130	46
IP2G09E	Develop students' skills relating to safe and appropriate use of ICT	68	129	46

Variable	Description	Denmark	Finland	Uruguay
IP2G09F	Develop students' proficiency in accessing and using info. with ICT	68	130	46
IP2G09G	Develop students' ability to write [apps] or programs	68	130	46
IP2G11A	Integrate web-based learning in their instructional practice	68	129	44
IP2G11B	Use ICT-based forms of student assessment	68	130	44
IP2G11C	Use ICT for monitoring student progress	68	130	44
IP2G11G	Integrate ICT into teaching and learning	68	128	44
IP2G11H	Use subject-specific digital learning resources (e.g. tutorial, simulation)	67	129	43
IP2G11I	Use e-portfolios for assessment	67	130	44
IP2G11J	Use ICT to develop authentic (real-life) assignments for students	68	129	44
IP2G11K	Assess students' [computer and information literacy]	68	129	44
IP2G11D	Collaborate with other teachers via ICT	68	130	43
IP2G11E	Communicate with parents via ICT	68	130	43
IP2G11F	Communicate with students via ICT	68	130	44
IP2G15A	Increase the number of computers per student in the school	67	128	40
IP2G15B	Increase the number of computers connected to the Internet	67	128	40
IP2G15C	Increase the bandwidth of Internet access for computers	67	128	40
IP2G15D	Increase the range of digital learning resources available	67	128	39
IP2G15E	Establish or enhance an online learning support platform	67	128	40
IP2G15F	Support participation in prof. dev. on pedagogical use of ICT	67	128	39
IP2G15G	Increase availability of qualified tech. personnel to support ICT use	67	127	39
IP2G15H	Provide teachers with incentives to integrate ICT use in their teaching	66	128	40
IP2G15I	Provide more time for teachers to prepare lessons where ICT is used	67	128	40
IP2G15J	Increase prof. learning resources for teachers in the use of ICT	67	127	40

Table A.3: Number of school ICT coordinators responding to each item

Variable	Description	Denmark	Finland	Uruguay
II2G04A	Digital learning resources that can be accessed offline	62	128	56
II2G04B	Digital learning resources that can only be used online	63	131	57
II2G04C	Access to the Internet through the school network	63	132	57
II2G04D	Access to education site/network maintained by ed. authorities	61	131	57
II2G04E	Email accounts for school-related use	63	132	57
II2G05A	Practice programs where teachers decide which questions are asked	58	131	57
II2G05B	Single user digital learning games (e.g., [languages online])	58	130	56
II2G05C	Multi-user digital learning games with graphics and inquiry tasks	58	129	55
II2G05D	Word-processing software (e.g., [Microsoft Word®])	59	132	57
II2G05E	Presentation software (e.g., [Microsoft PowerPoint®])	59	132	56
II2G05F	Video and photo software for capture and editing	58	132	57
II2G05G	Concept mapping software (e.g., [Inspiration®], [Webspiration®])	57	130	56
II2G05H	Data logging and monitoring tools that capture data for analysis	57	128	55
II2G05I	Simulations and modelling software (e.g., [NetLogo])	56	130	55

Variable	Description	Denmark	Finland	Uruguay
II2G05J	A learning management system (e.g., [Edmodo], [Blackboard])	57	132	57
II2G05K	Graphing or drawing software	58	131	56
II2G05L	e-portfolios (e.g., [VoiceThread])	57	128	57
II2G05M	Digital contents linked with textbooks	56	130	55
II2G05N	Social media (e.g., [Facebook, Twitter])	58	129	57
II2G06A	Remote access to a school network	58	130	56
II2G06B	Space on a school network to store files	59	131	53
II2G06C	A school intranet with applications and workspaces	57	132	53
II2G06D	Internet-based applications for collaborative work	59	132	56
II2G06E	A 3D printer	58	132	54
II2G06F	Robots or robotic devices	58	131	55
II2G06G	Access to a wireless LAN (wifi)	59	132	56
II2G06H	A learning management system (e.g., [WebCT®], [Moodle])	58	130	56
II2G13A	Too few computers connected to the Internet	56	130	53
II2G13B	Insufficient Internet bandwidth or speed	56	130	54
II2G13C	Not enough computers for instruction	56	130	54
II2G13D	Lack of sufficiently powerful computers	56	130	53
II2G13E	Problems in maintaining ICT equipment	56	130	53
II2G13F	Not enough computer software	56	130	52
II2G13G	Insufficient ICT skills among teachers	56	129	52
II2G13H	Insufficient time for teachers to prepare lessons	55	129	54
II2G13I	Lack of effective professional learning resources for teachers	56	129	53
II2G13J	Lack of an effective online learning support platform	56	128	52
II2G13K	Lack of incentives for teachers to integrate ICT in teaching	56	129	53
II2G13L	Restricted access to useful Internet resources	56	128	52
II2G13M	Insufficient technical ICT support	56	129	53
II2G13N	Insufficient pedagogical support for the use of ICT	56	129	52

APPENDIX B

Changes in the use of ICT (percentages)

B.1 Teacher survey

Figure B.1: Percentages of teachers who reported that they have never used ICT during lessons and when preparing lessons

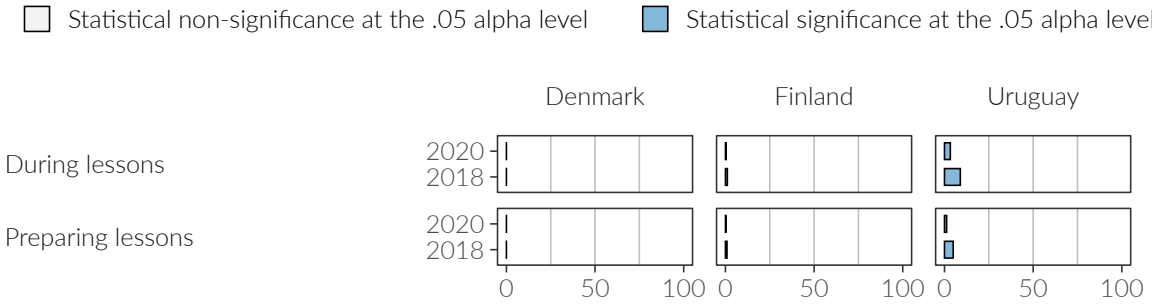


Figure B.2: Percentages of teachers who reported using ICT every day

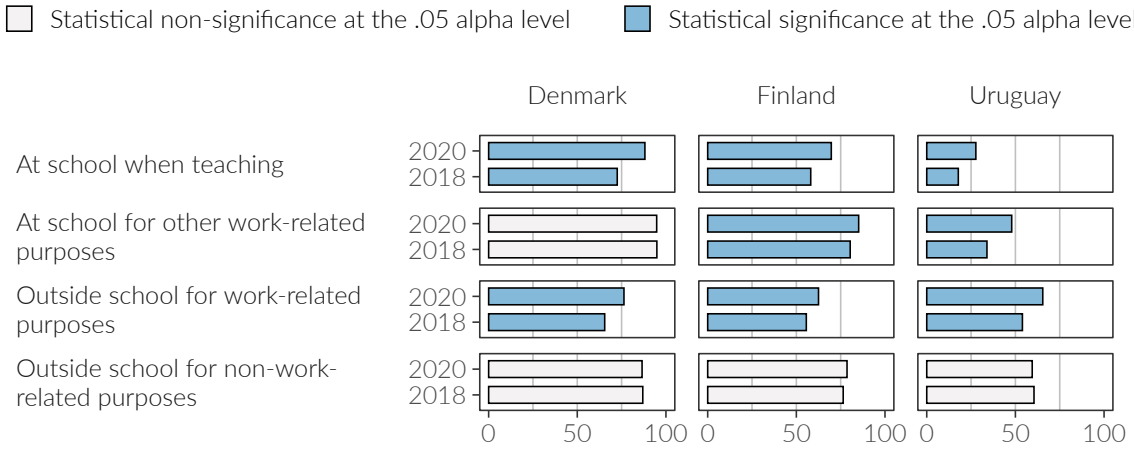


Figure B.3: Percentages of teachers who reported that they knew how to do different ICT tasks

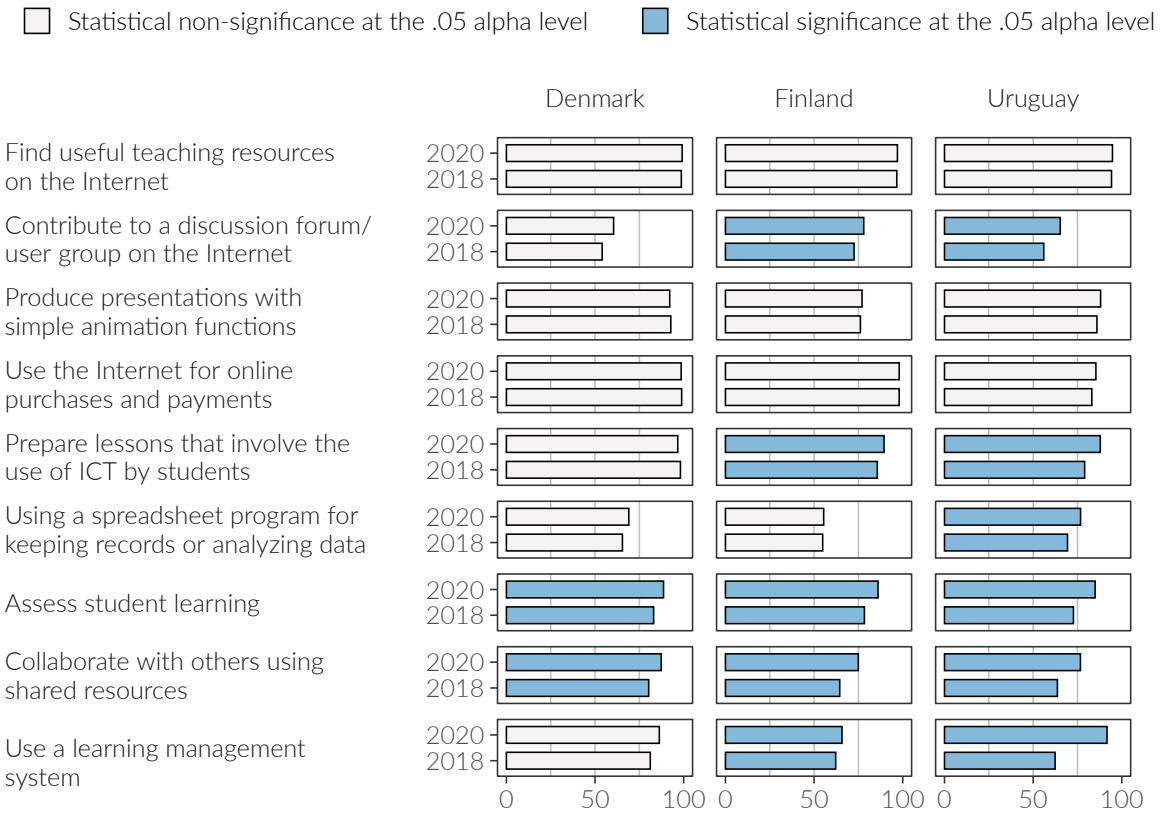


Figure B.4: Percentages of teachers agreeing with statements about positive outcomes of the use of ICT for teaching and learning

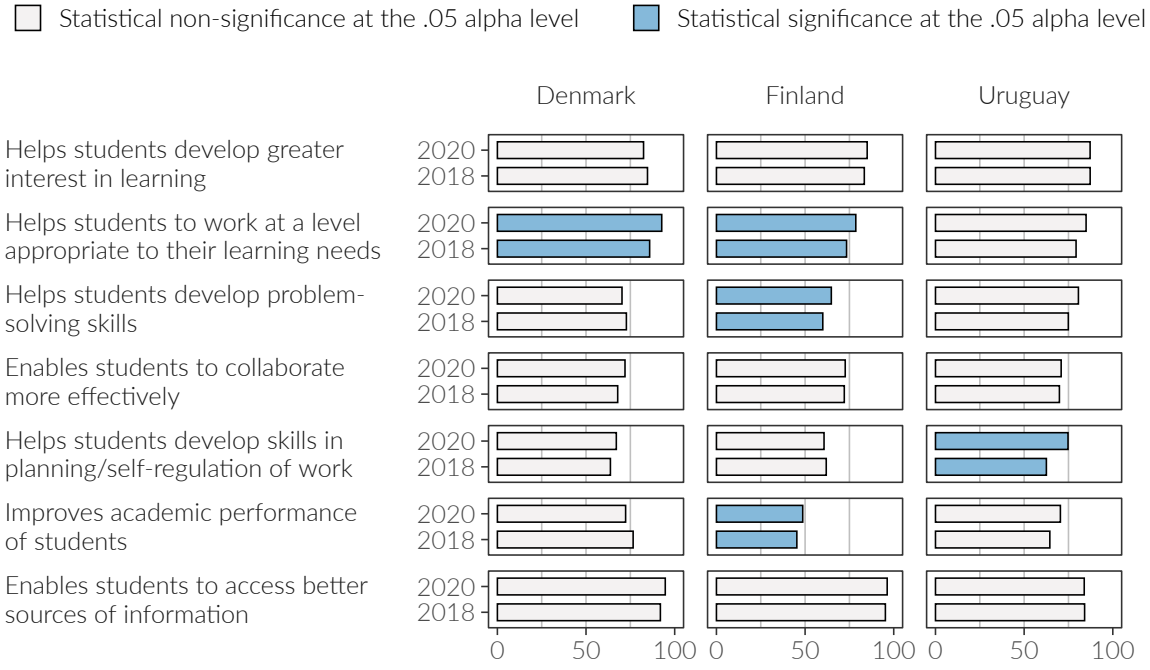


Figure B.5: Percentages of teachers agreeing with statements about negative outcomes of the use of ICT for teaching and learning

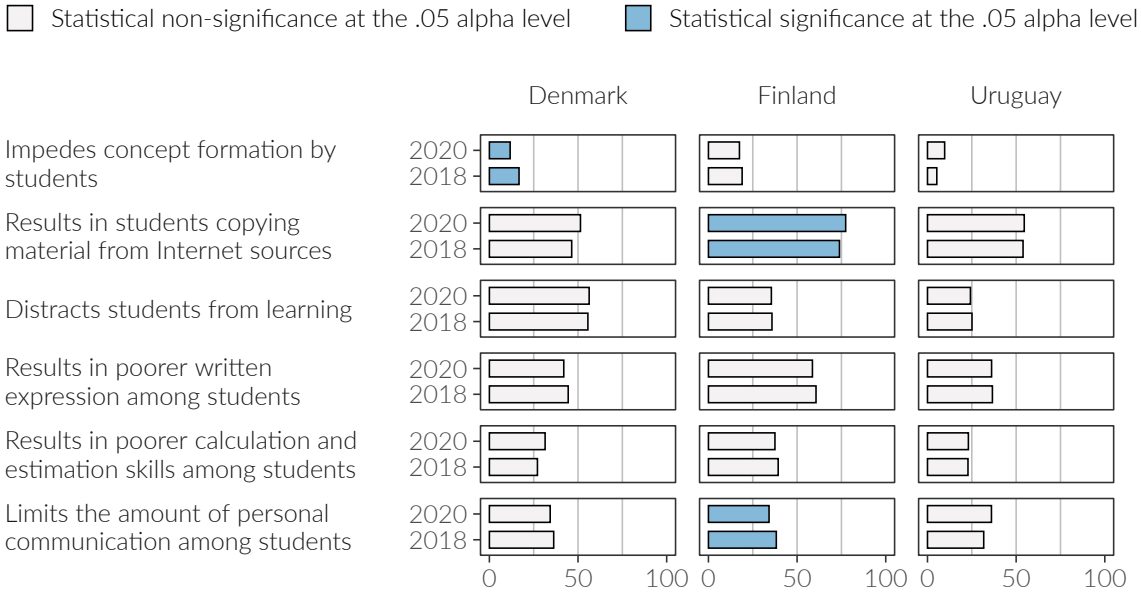


Figure B.6: Percentages of teachers agreeing with statements about the availability of ICT for teaching at school

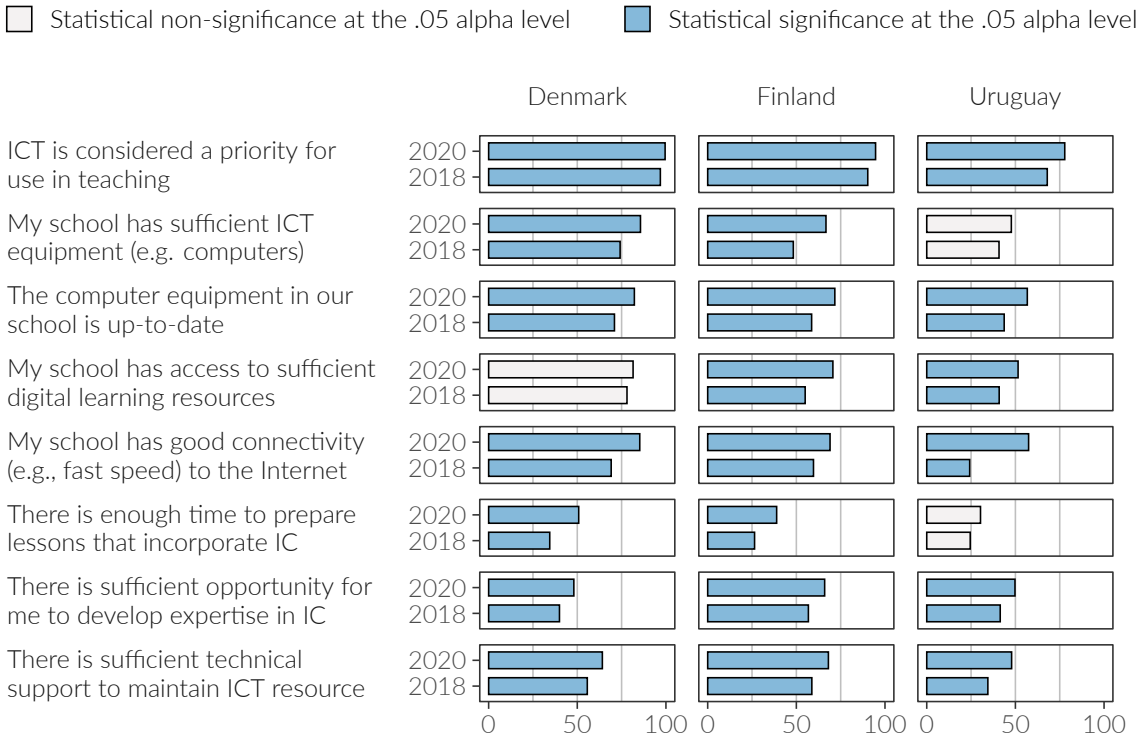


Figure B.7: Percentages of teachers agreeing with statements about the collaborative use of ICT in teaching and learning

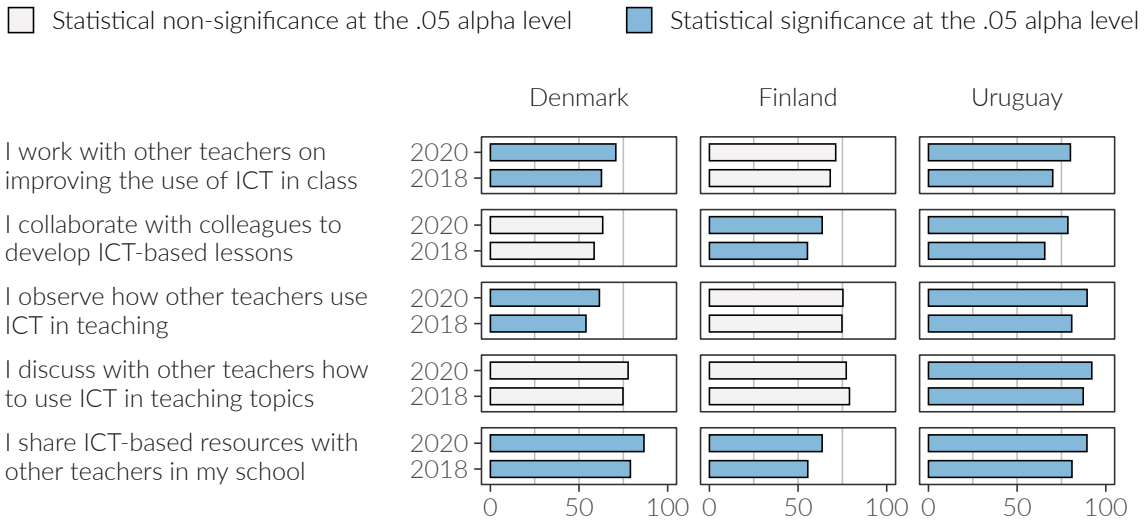


Figure B.8: Percentages of teachers who reported some or strong emphasis on developing CIL-related skills in class

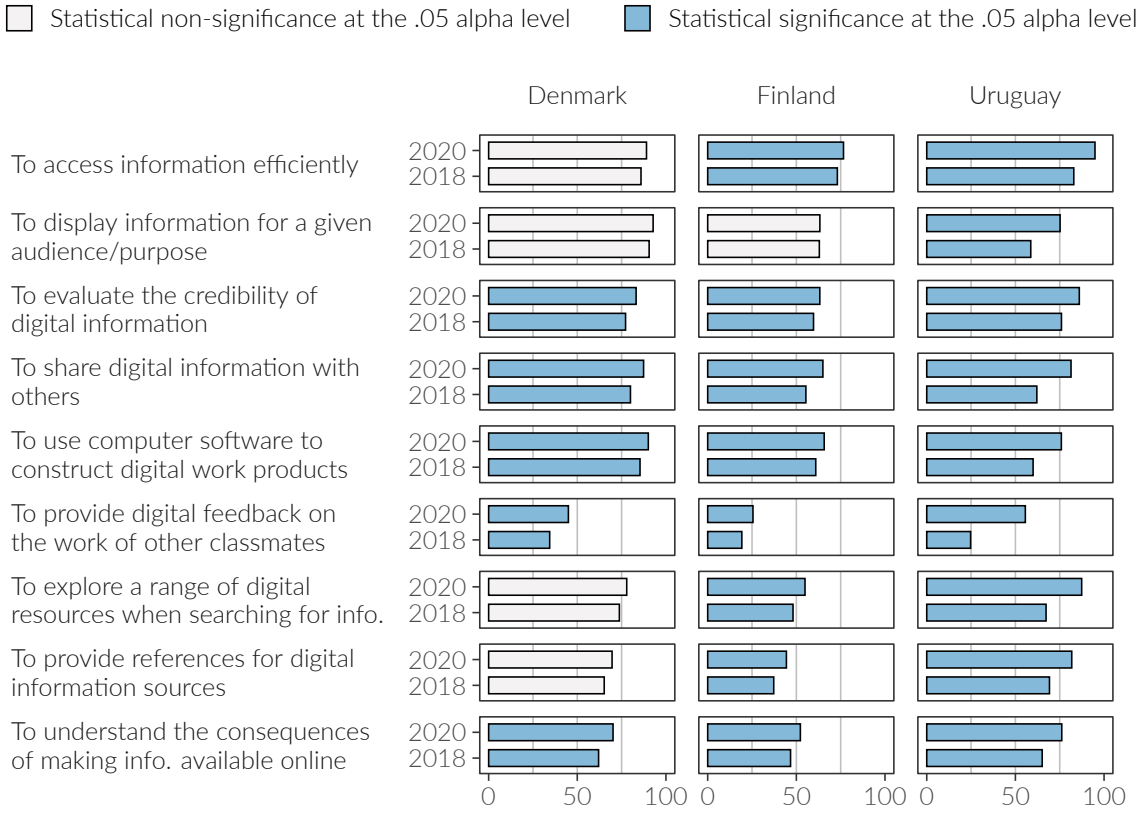


Figure B.9: Percentages of teachers who reported some or strong emphasis on developing CT-related skills in class

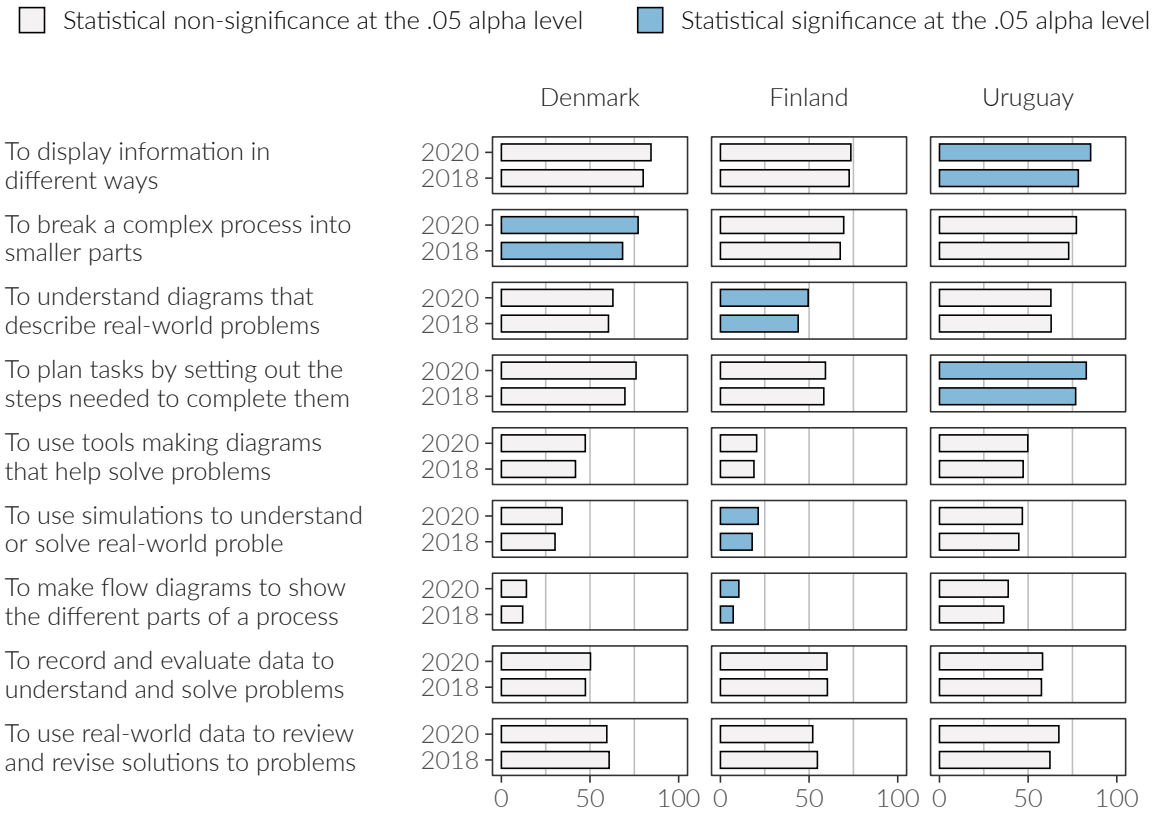


Figure B.10: Percentages of teachers who reported using general utility ICT tools in most lessons, almost every, or every lesson

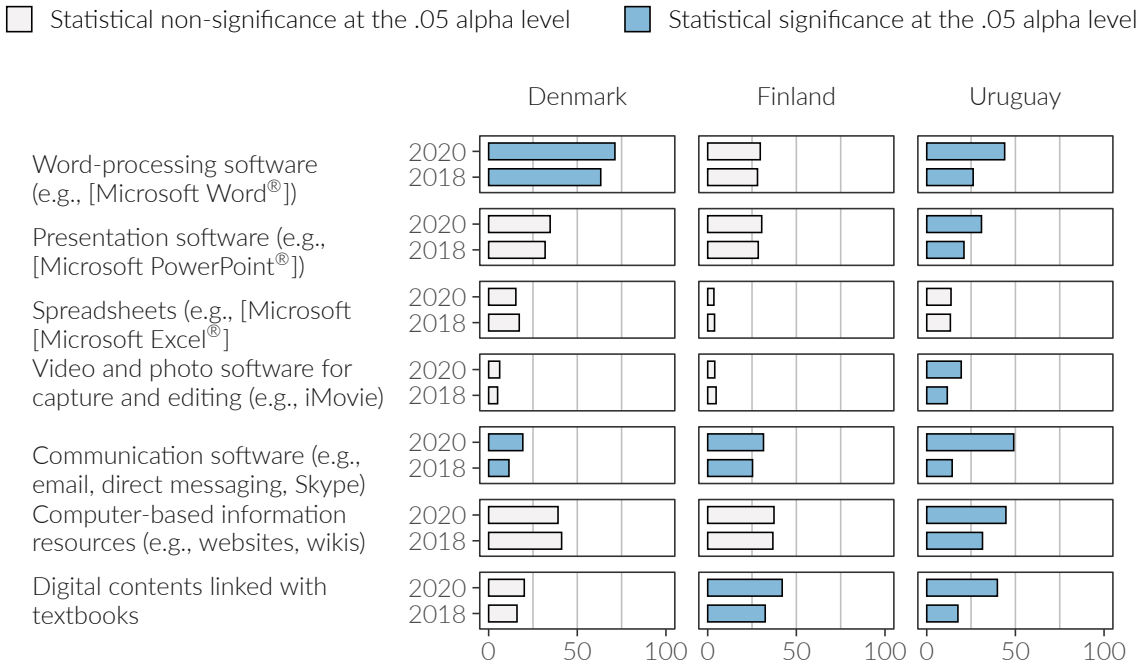


Figure B.11: Percentages of teachers who reported using digital learning ICT tools in most lessons, almost every, or every lesson

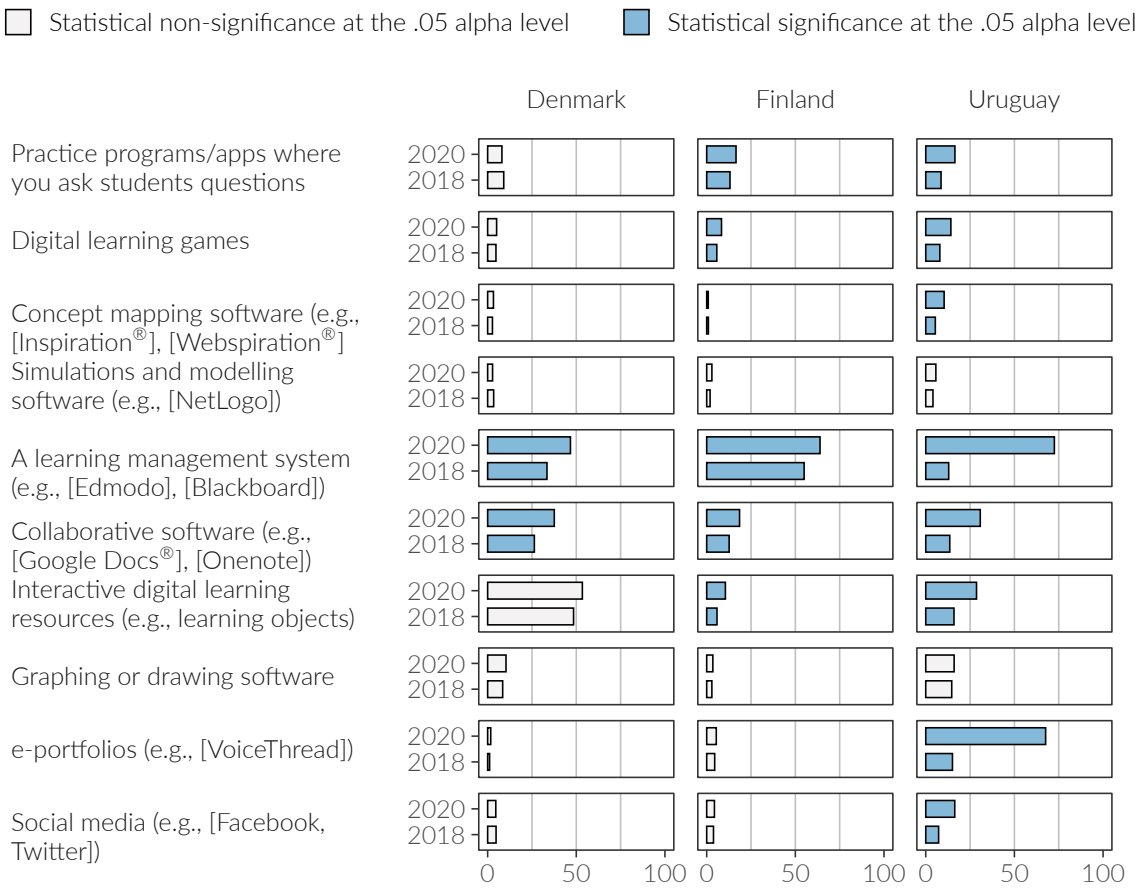


Figure B.12: Percentages of teachers who reported that students used ICT often or always when engaging in different class activities

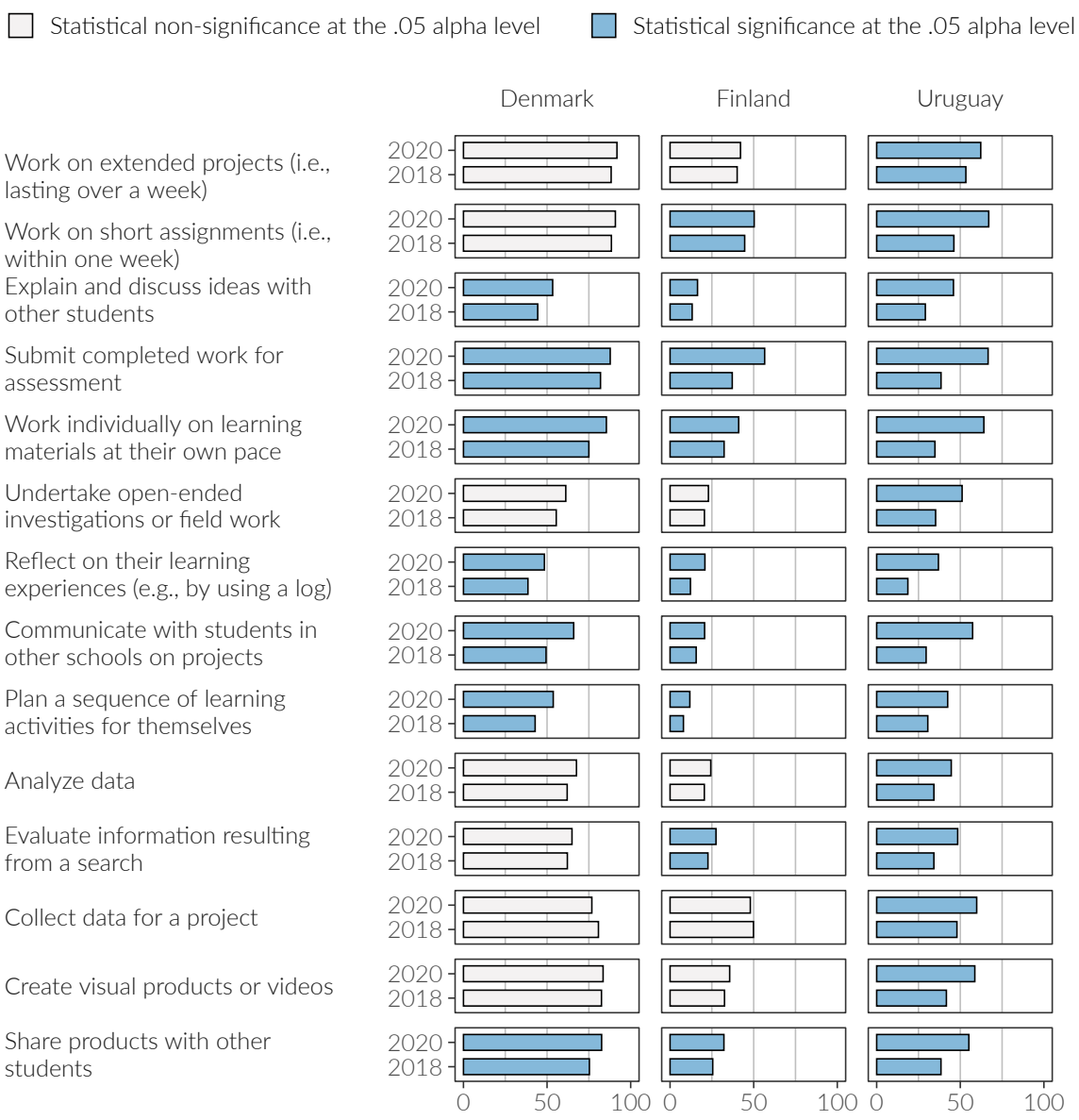
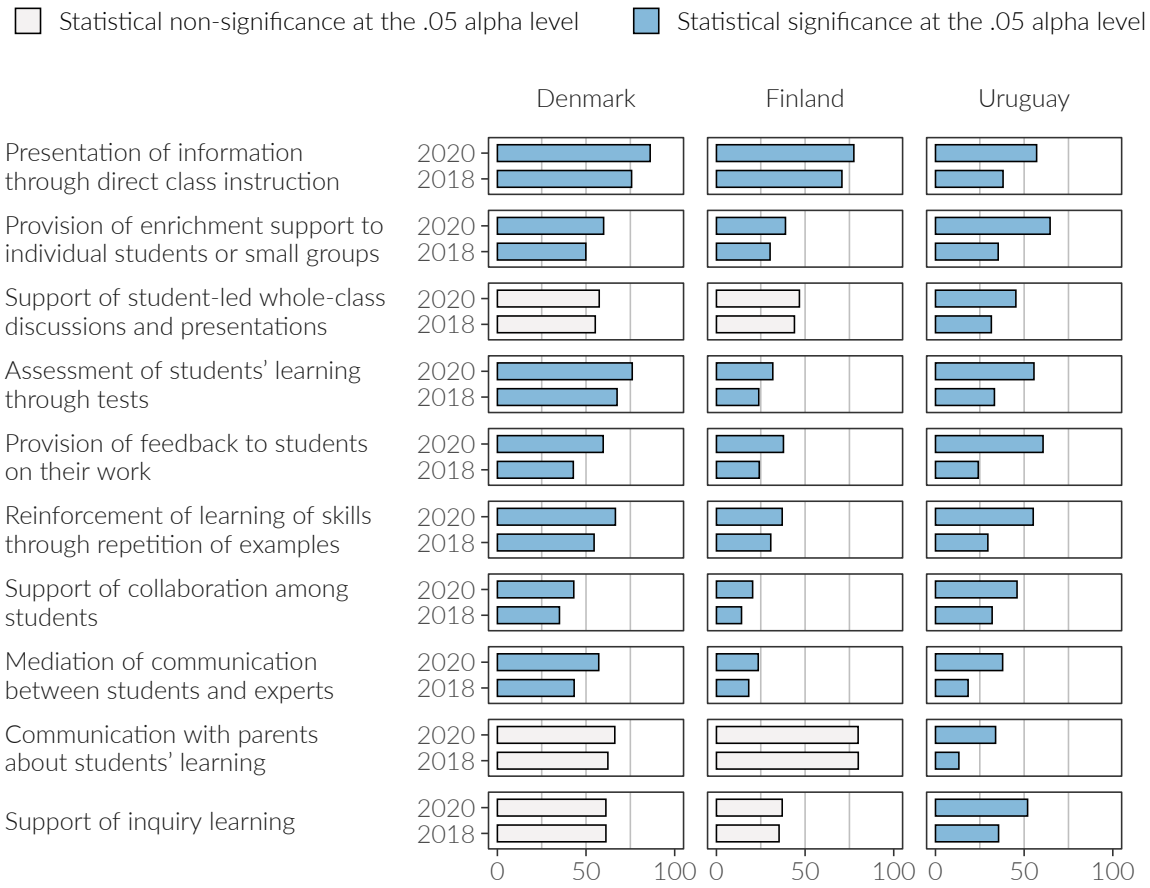


Figure B.13: Percentages of teachers who reported using ICT often or always for different teaching practices



B.2 School principal survey

Figure B.14: Percentages of principals who reported using ICT for general school-related activities at least once a week but not every day or everyday

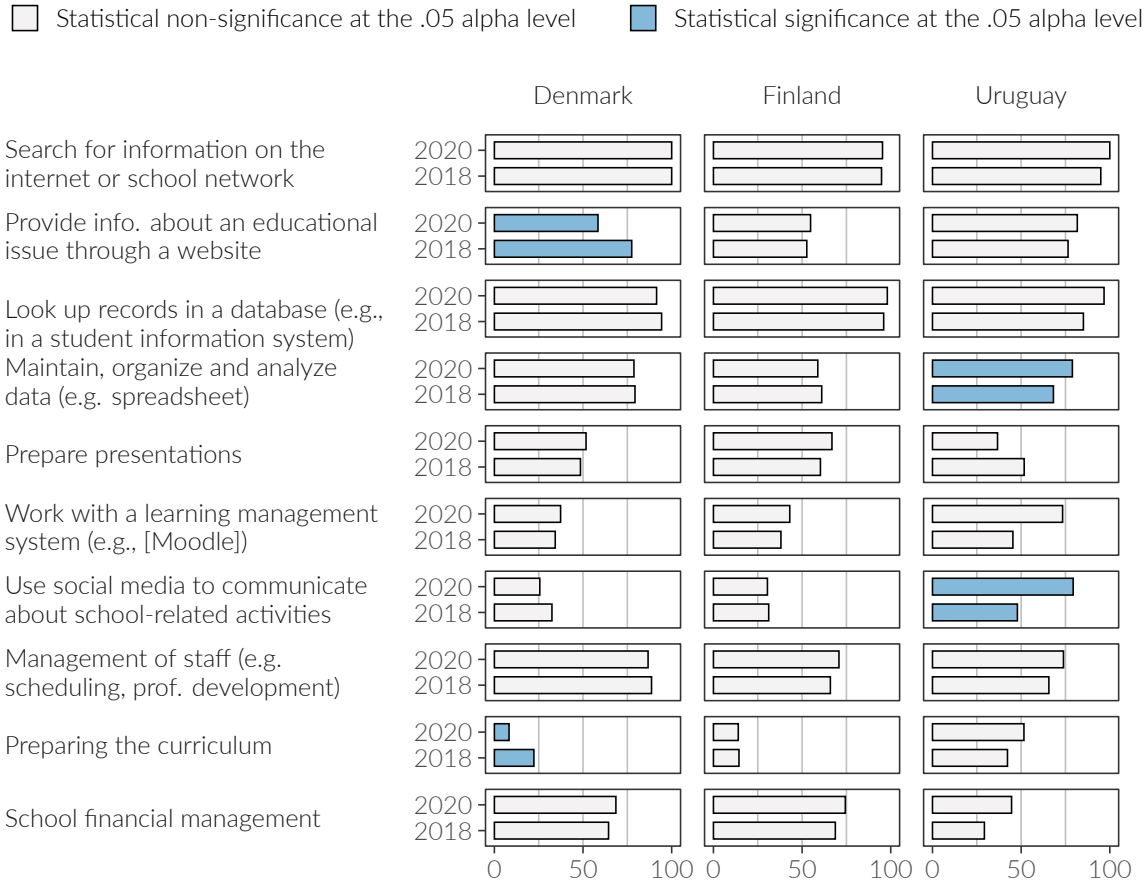


Figure B.15: Percentages of principals who reported using ICT for school-related communication activities at least once a week but not every day or everyday

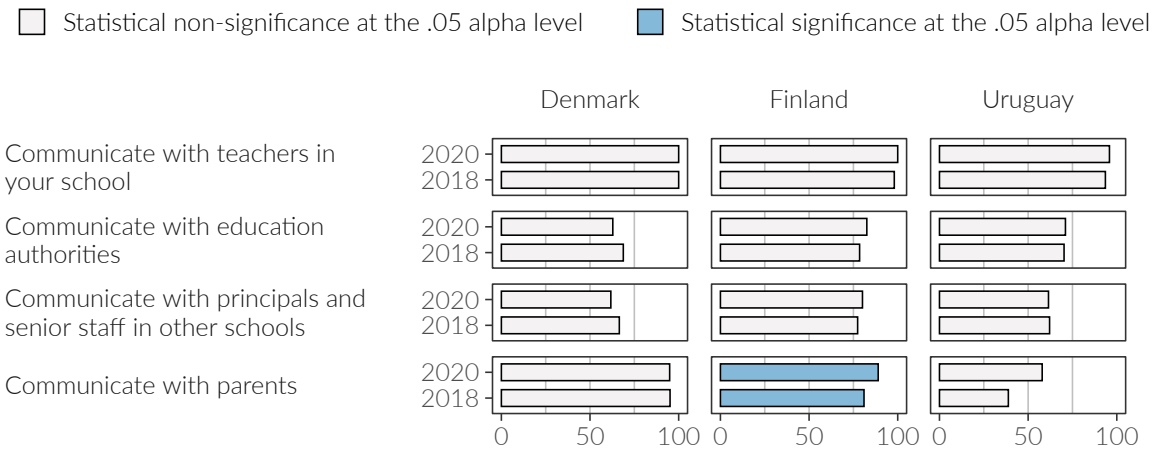


Figure B.16: Percentages of principals who viewed ICT-related outcomes as quite important or very important

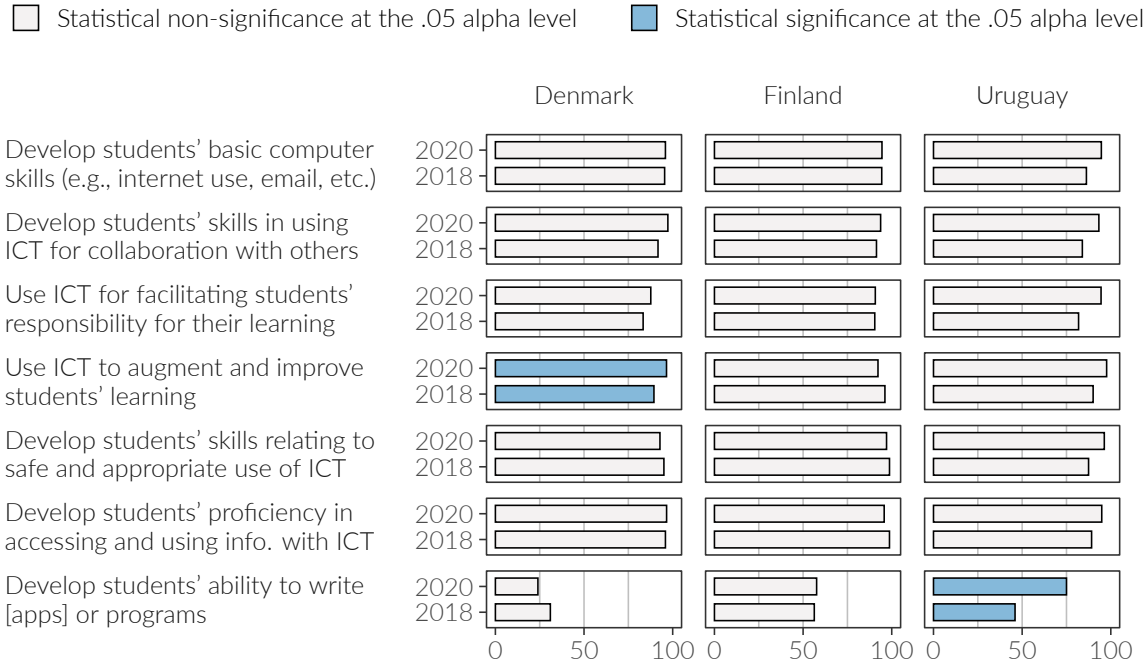


Figure B.17: Percentages of principals who reported teachers are expected and required to use ICT

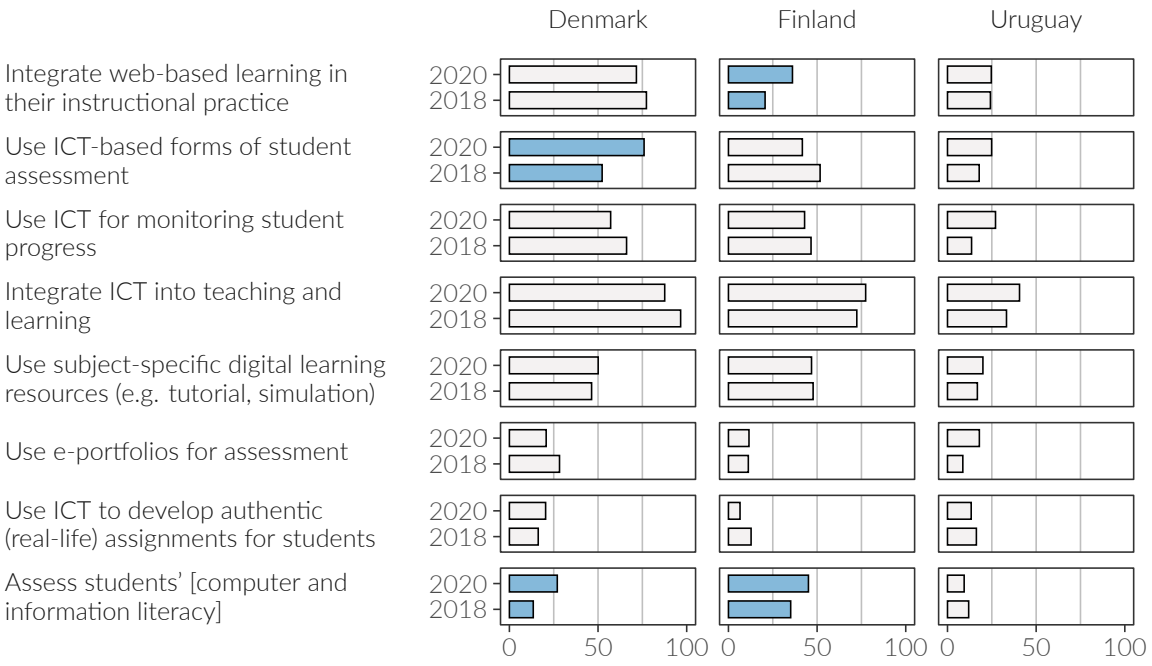


Figure B.18: Percentages of principals who reported teachers are expected and required to use ICT for collaboration

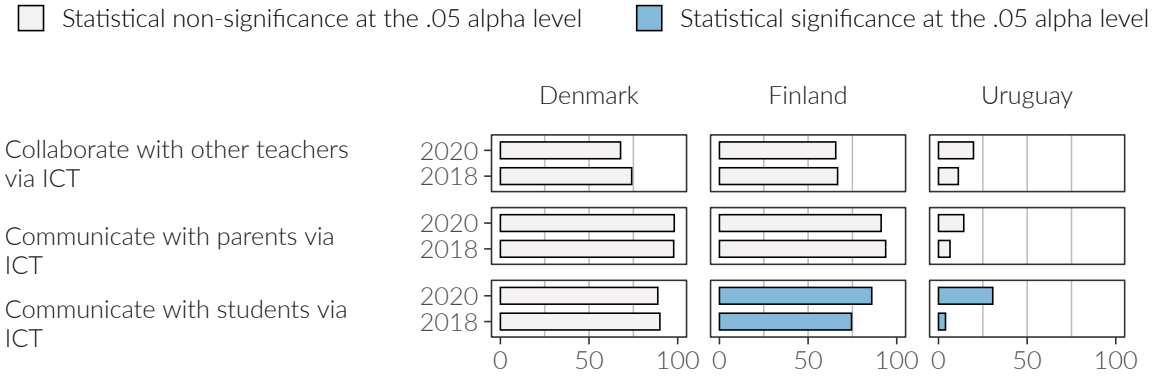


Figure B.19: Percentages of principals who reported giving moderate or high priority to providing infrastructure support to facilitate teaching and learning

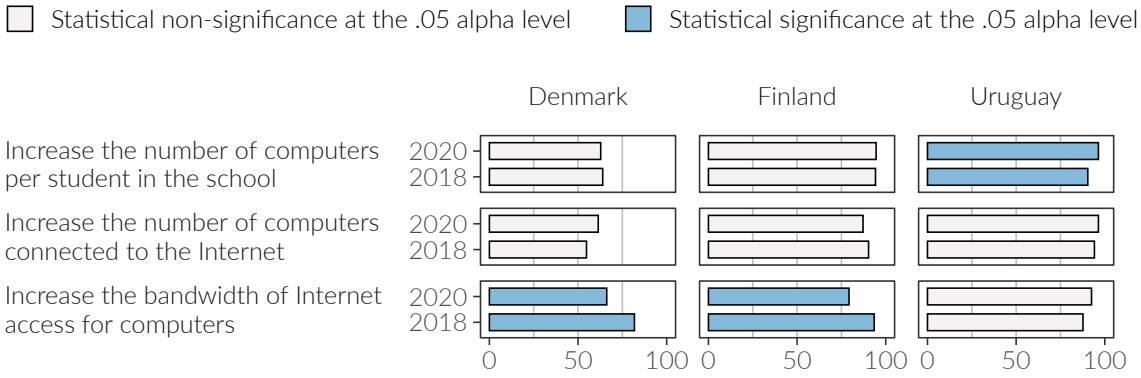
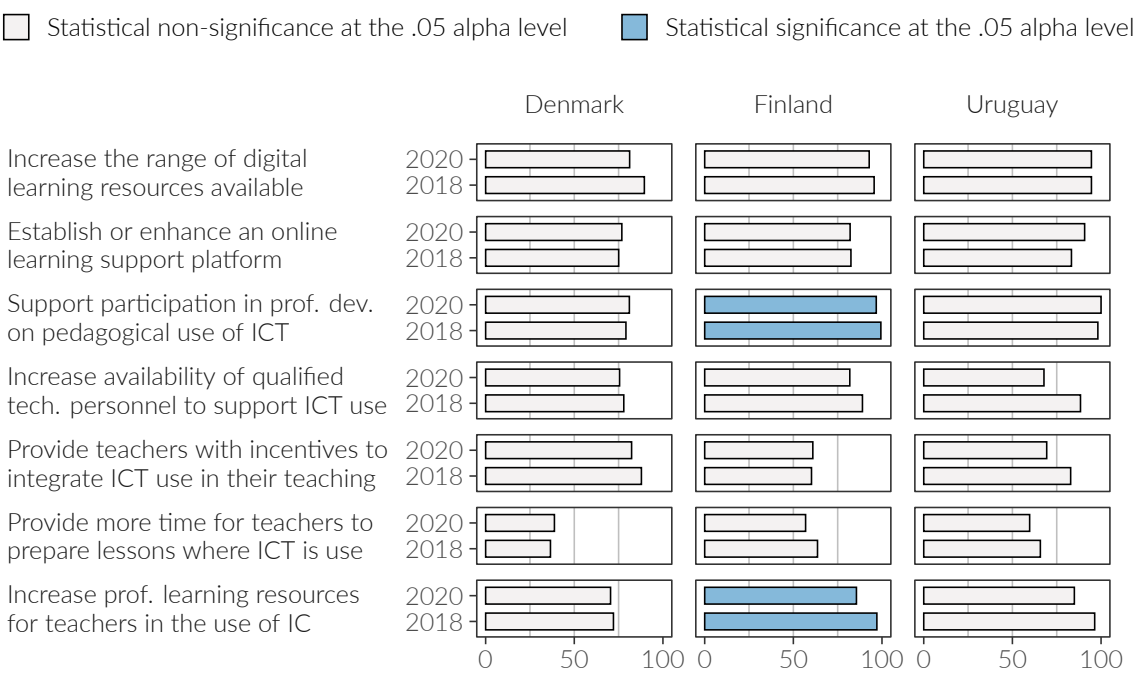


Figure B.20: Percentages of principals who reported giving moderate or high priority to providing general ICT resources and pedagogical support



B.3 School ICT coordinator survey

Figure B.21: Percentages of ICT coordinators who indicated that the following technology-related resources are available for both teachers and students

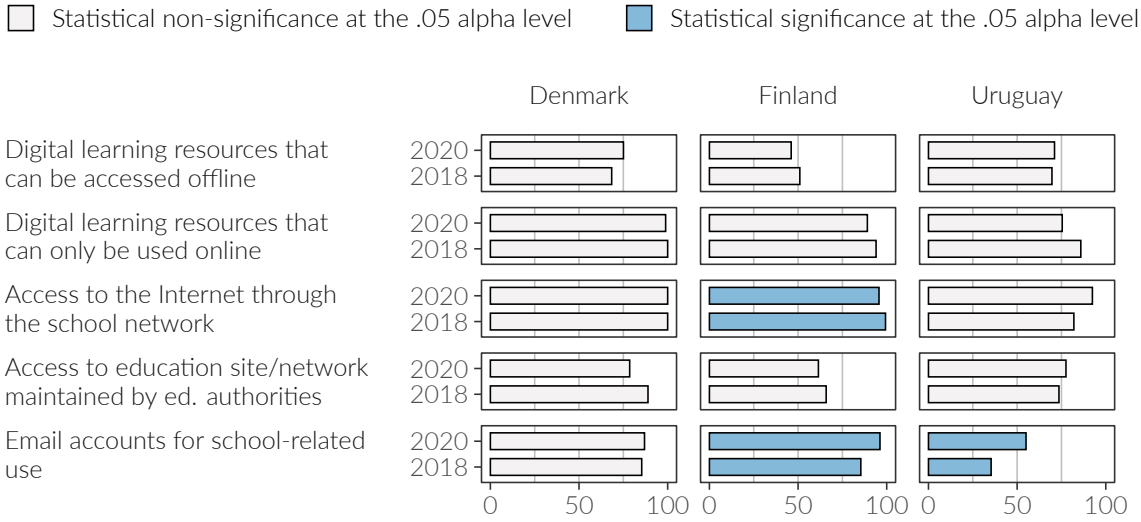


Figure B.22: Percentages of ICT coordinators who indicated that the following software-related resources are available for both teachers and students

Figure B.23: Percentages of ICT coordinators who indicated that the following technology facilities are available for both teaching and learning

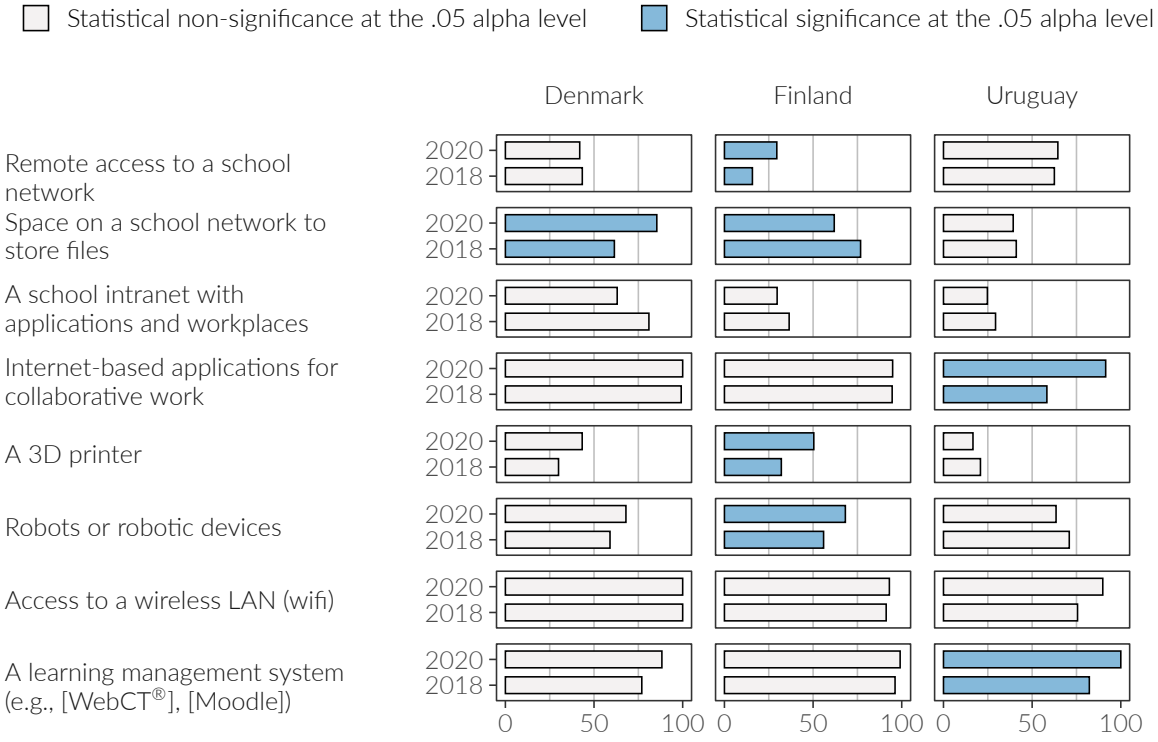


Figure B.24: Percentages of ICT coordinators who reported that the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient computer resources

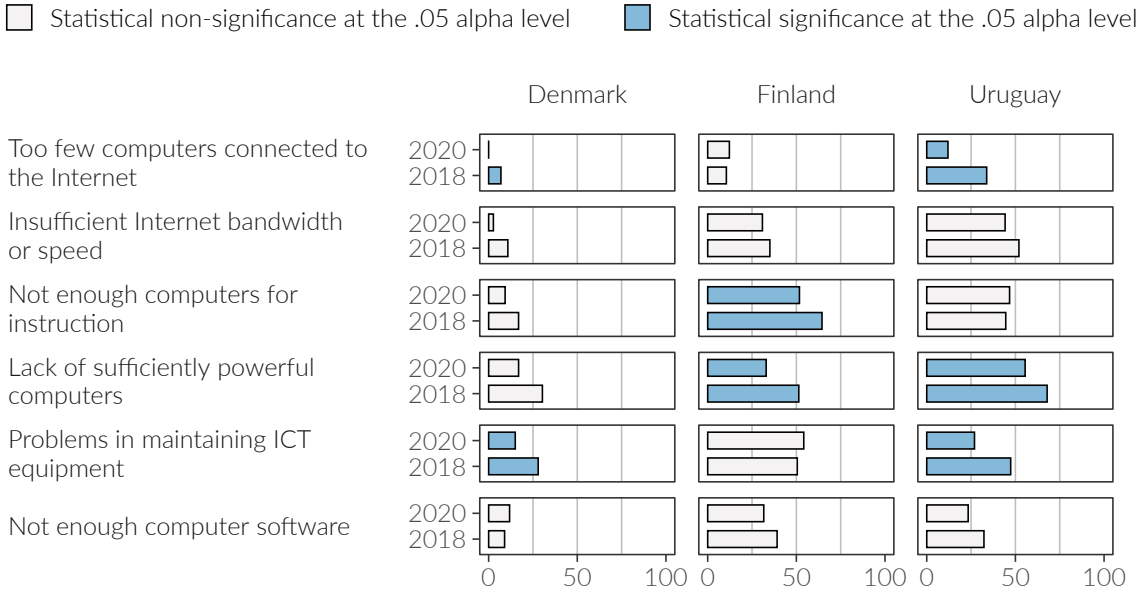
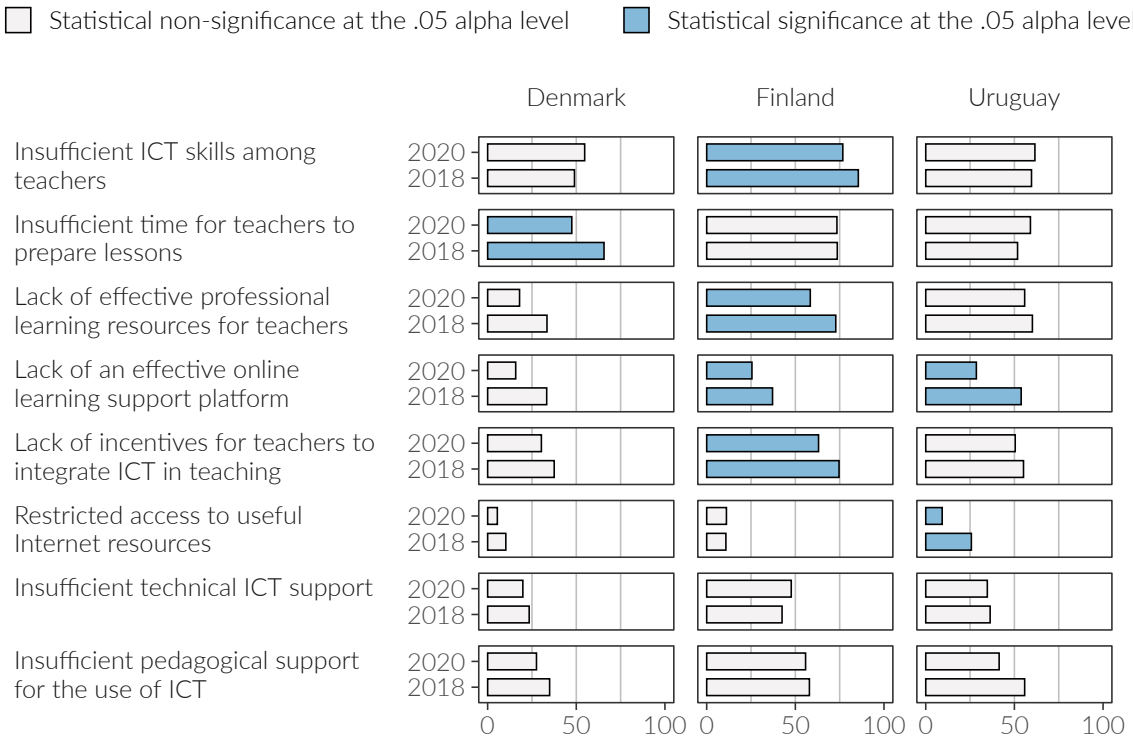


Figure B.25: Percentages of ICT coordinators who reported that the use of ICT for teaching and learning was hindered a lot or to some extent by insufficient pedagogical resources



APPENDIX C

Variables derived from the questionnaire data

C.1 Teacher survey

Description:	Experience with using ICT		
Source:	Approximately how long have you been using ICT for teaching purposes?		
	During lessons	T_EXLES	
	Preparing lessons	T_EXPREP	
			Recoding
	1 = Never	0	1
	2 = Less than two years	1	0
	3 = Between two and five years	2	0
	4 = More than five years	3	0

Description:	Teachers use ICT		
Source:	How often do you use ICT in these settings?		
	At school when teaching	IT2G06A	
	At school for other work-related purposes	IT2G06B	
	Outside school for work-related purposes	IT2G06C	
	Outside school for non-work-related purposes	IT2G06D	
			Recoding
	1 = Never	1	0
	2 = Less than once a month	2	0
	3 = At least once a month but not every week	3	0
	4 = At least once a week but not every day	4	0
	5 = Every day	5	1

Description:	Teachers ICT self-efficacy		
Source:	How well can you do these tasks using ICT?		
	Find useful teaching resources on the Internet	IT2G07A	
	Contribute to a discussion forum	IT2G07B	
	Produce presentations (e.g. [Microsoft PowerPoint® or a similar program]), with simple animation functions	IT2G07C	
	Use the Internet for online purchases and payments	IT2G07D	
	Prepare lessons that involve the use of ICT by students	IT2G07E	
	Using a spreadsheet program (e.g. [Microsoft Excel®]) for keeping records or analyzing data	IT2G07F	
	Assess student learning	IT2G07G	
	Collaborate with others using shared resources such as [Google Docs®], [Padlet]	IT2G07H	
	Use a learning management system (e.g. [Moodle], [Blackboard], [Edmodo])	IT2G07I	
			Recoding
	1 = I know how to do this	1	1
	2 = I haven"t done this but I could find out how	2	0
	3 = I do not think I could do this	3	0

Description:	Emphasis on ICT capabilities in class		
Source:	In your teaching the reference class in this school year, how much emphasis have you given to developing the following ICT-based capabilities in your students?		
	To access information efficiently	IT2G09A	
	To display information for a given audience or purpose	IT2G09B	
	To evaluate the credibility of digital information	IT2G09C	
	To share digital information with others	IT2G09D	
	To use computer software to construct digital work products (e.g. presentations, documents, images and diagrams)	IT2G09E	
	To provide digital feedback on the work of others (such as classmates)	IT2G09F	
	To explore a range of digital resources when searching for information	IT2G09G	
	To provide references for digital information sources	IT2G09H	
	To understand the consequences of making information publicly available online	IT2G09I	
			Recoding
	1 = Strong emphasis	1	1
	2 = Some emphasis	2	1
	3 = Little emphasis	3	0
	4 = No emphasis	4	0

Description:	Use of ICT for classroom activities		
Source:	How often do students in your reference class use ICT for the following activities?		
	Work on extended projects (i.e. lasting over a week)	IT2G10A	
	Work on short assignments (i.e. within one week)	IT2G10B	
	Explain and discuss ideas with other students	IT2G10C	
	Submit completed work for assessment	IT2G10D	
	Work individually on learning materials at their own pace	IT2G10E	
	Undertake open-ended investigations or field work	IT2G10F	
	Reflect on their learning experiences (e.g. by using a learning log)	IT2G10G	
	Communicate with students in other schools on projects	IT2G10H	
	Plan a sequence of learning activities for themselves	IT2G10I	
	Analyze data	IT2G10J	
	Evaluate information resulting from a search	IT2G10K	
	Collect data for a project	IT2G10L	
	Create visual products or videos	IT2G10M	
	Share products with other students	IT2G10N	
			Recoding
	1 = They do not engage in this activity	1	Missing
	2 = They never use ICT in this activity	2	0
	3 = They sometimes use ICT in this activity	3	0
	4 = They often use ICT in this activity	4	1
	5 = They always use ICT in this activity	5	1

Description:	Use of ICT for teaching practices in class		
Source:	How often do you use ICT with the following practices when teaching your reference class?		
	The presentation of information through direct class instruction	IT2G11A	
	The provision of remedial or enrichment support to individual students or small groups of students	IT2G11B	
	The support of student-led whole-class discussions and presentations	IT2G11C	
	The assessment of students' learning through tests	IT2G11D	
	The provision of feedback to students on their work	IT2G11E	
	The reinforcement of learning of skills through repetition of examples	IT2G11F	
	The support of collaboration among students	IT2G11G	
	The mediation of communication between students and experts or external mentors	IT2G11H	
	The communication with parents or [guardians] about students' learning	IT2G11I	
	The support of inquiry learning	IT2G11J	
			Recoding
	1 = I do not use this practice with the reference class	1	Missing
	2 = I never use ICT with this practice	2	0
	3 = I sometimes use ICT with this practise	3	0
	4 = I often use ICT with this practise	4	1
	5 = I always use ICT with this practise	5	1

Description:	Use of digital learning tools		
Source:	How often did you use the following tools in your teaching of the reference class this school year?		
	Practice programs or apps where you ask students questions (e.g. [Quizlet, Kahoot], [mathfessor])	IT2G12A	
	Digital learning games	IT2G12B	
	Concept mapping software (e.g. [Inspiration®], [Webspiration®])	IT2G12G	
	Simulations and modelling software (e.g. [NetLogo])	IT2G12H	
	A learning management system (e.g. [Edmodo], [Blackboard])	IT2G12I	
	Collaborative software (e.g. [Google Docs®], [Onenote]) [Padlet])	IT2G12K	
	Interactive digital learning resources (e.g. learning objects)	IT2G12M	
	Graphing or drawing software	IT2G12N	
	e-portfolios (e.g. [VoiceThread])	IT2G12O	
	Social media (e.g. [Facebook, Twitter])	IT2G12Q	
			Recoding
	1 = Never	1	0
	2 = In some lessons	2	0
	3 = In most lessons	3	1
	4 = In every or almost every lesson	4	1

Description:	Use of general utility software		
Source:	How often did you use the following tools in your teaching of the reference class this school year?		
	Word-processor software (e.g. [Microsoft Word®])	IT2G12C	
	Presentation software (e.g. [Microsoft PowerPoint®])	IT2G12D	
	Spreadsheets (e.g. [Microsoft Excel®])	IT2G12E	
	Video and photo software for capture and editing (e.g. [Windows Movie Maker, iMovie, Adobe Photoshop])	IT2G12F	
	Communication software (e.g. email, direct messaging, Skype)	IT2G12J	
	Computer-based information resources (e.g. topic-related websites, wikis, encyclopedia)	IT2G12L	
	Digital contents linked with textbooks	IT2G12P	
			Recoding
	1 = Never	1	0
	2 = In some lessons	2	0
	3 = In most lessons	3	1
	4 = In every or almost every lesson	4	1

Description:	Teacher emphasis of teaching coding tasks in class		
Source:	In your teaching of the reference class this school year, how much emphasis have you given to teaching the following skills?		
	To display information in different ways	IT2G13A	
	To break a complex process into smaller parts	IT2G13B	
	To understand diagrams that describe or show real-world problems	IT2G13C	
	To plan tasks by setting out the steps needed to complete them	IT2G13D	
	To use tools making diagrams that help solve problems	IT2G13E	
	To use simulations to help understand or solve real-world problems	IT2G13F	
	To make flow diagrams to show the different parts of a process	IT2G13G	
	To record and evaluate data to understand and solve a problem	IT2G13H	
	To use real-world data to review and revise solutions to problems	IT2G13I	
			Recoding
	1 = Strong emphasis	1	1
	2 = Some emphasis	2	1
	3 = Little emphasis	3	0
	4 = No emphasis	4	0

Description:	Availability of computer resources at school		
Source:	To what extent do you agree or disagree with the following statements about the use of ICT in teaching at your school?		
	ICT is considered a priority for use in teaching	IT2G14A	
	My school has sufficient ICT equipment (e.g. computers)	IT2G14B	
	The computer equipment in our school is up-of-date	IT2G14C	
	My school has access to sufficient digital learning resources (e.g. learning software or [apps])	IT2G14D	
	My school has good connectivity (e.g. fast speed and stable) to the Internet	IT2G14E	
	There is enough time to prepare lessons that incorporate ICT	IT2G14F	
	There is sufficient opportunity for me to develop expertise in ICT	IT2G14G	
	There is sufficient technical support to maintain ICT resources	IT2G14H	
			Recoding
	1 = Strongly agree	1	1
	2 = Agree	2	1
	3 = Disagree	3	0
	4 = Strongly disagree	4	0

Description:	Collaboration between teachers in using ICT		
Source:	To what extent do you agree or disagree with the following statements about your use of ICT in teaching and learning at your school?		
	I work together with other teachers on improving the use of ICT in classroom teaching	IT2G15A	
	I collaborate with colleagues to develop ICT-based lessons	IT2G15B	
	I observe how other teachers use ICT in teaching	IT2G15C	
	I discuss with other teachers how to use ICT in teaching topics	IT2G15D	
	I share ICT-based resources with other teachers in my school	IT2G15E	
			Recoding
	1 = Strongly agree	1	1
	2 = Agree	2	1
	3 = Disagree	3	0
	4 = Strongly disagree	4	0

Description:	Negative views on using ICT in teaching and learning		
Source:	To what extent do you agree or disagree with the following statements about using ICT in teaching and learning at school?		
	Impedes concept formation by students	IT2G18A	
	Results in students copying material from Internet sources	IT2G18D	
	Distracts students from learning	IT2G18F	
	Results in poorer written expression among students	IT2G18G	
	Results in poorer calculation and estimation skills among students	IT2G18H	
	Limits the amount of personal communication among students	IT2G18I	
			Recoding
	1 = Strongly agree	1	1
	2 = Agree	2	1
	3 = Disagree	3	0
	4 = Strongly disagree	4	0

Description:	Positive views on using ICT in teaching and learning		
Source:	To what extent do you agree or disagree with the following statements about using ICT in teaching and learning at school?		
	Helps students develop greater interest in learning	IT2G18B	
	Helps students to work at a level appropriate to their learning needs	IT2G18C	
	Helps students develop problem solving skills	IT2G18E	
	Enables students to collaborate more effectively	IT2G18J	
	Helps students develop skills in planning and self-regulation of their work	IT2G18K	
	Improves academic performance of students	IT2G18L	
	Enables students to access better sources of information	IT2G18M	
			Recoding
	1 = Strongly agree	1	1
	2 = Agree	2	1
	3 = Disagree	3	0
	4 = Strongly disagree	4	0

C.2 School principal survey

Description:	Principal use of ICT for general school-related activities		
Source:	How often do you use ICT for the following activities?		
	Search for information on the Internet or a network maintained by education authorities for its schools	IP2G02A	
	Provide information about an educational issue through a website	IP2G02B	
	Look up records in a database (e.g. in a student information system)	IP2G02C	
	Maintain, organise and analyse data (e.g. with a spreadsheet or database)	IP2G02D	
	Prepare presentations	IP2G02E	
	Work with a learning management system (e.g. [Moodle])	IP2G02J	
	Use social media to communicate with the wider community about school-related activities	IP2G02K	
	Management of staff (e.g. scheduling, professional development)	IP2G02L	
	Preparing the curriculum	IP2G02M	
	School financial management	IP2G02N	
			Recoding
	1 = Never	1	0
	2 = Less than once a month	2	0
	3 = At least once a month but not every week	3	0
	4 = At least once a week but not every day	4	1
	5 = Every day	5	1

Description:	Principal use of ICT for school-related communication activities		
Source:	How often do you use ICT for the following activities?		
	Communicate with teachers in your school	IP2G02F	
	Communicate with education authorities	IP2G02G	
	Communicate with principals and senior staff in other schools	IP2G02H	
	Communicate with parents	IP2G02I	
			Recoding
	1 = Never	1	0
	2 = Less than once a month	2	0
	3 = At least once a month but not every week	3	0
	4 = At least once a week but not every day	4	1
	5 = Every day	5	1

Description:	View on using ICT for educational outcomes		
Source:	How important is each of the following outcomes of education in your school?		
	The development of students' basic computer skills (e.g. internet use, email, word processing, presentation software)	IP2G09A	
	The development of students' skills in using ICT for collaboration with others	IP2G09B	
	The use of ICT for facilitating students' responsibility for their own learning	IP2G09C	
	The use of ICT to augment and improve students' learning	IP2G09D	
	The development of students' understanding and skills relating to safe and appropriate use of ICT	IP2G09E	
	The development of students' proficiency in accessing and using information with ICT	IP2G09F	
	The development of students' ability to write [apps] or programs	IP2G09G	
			Recoding
	1 = Very important	1	1
	2 = Quite important	2	1
	3 = Somewhat important	3	0
	4 = Not important	4	0

Description:	ICT use expected of teachers		
Source:	Are teachers in your school expected to acquire knowledge and skills in each of the following activities?		
	Integrate Web-based learning in their instructional practice	IP2G11A	
	Use ICT-based forms of student assessment	IP2G11B	
	Use ICT for monitoring student progress	IP2G11C	
	Integrate ICT into teaching and learning	IP2G11G	
	Use subject-specific digital learning resources (e.g. tutorials, simulation)	IP2G11H	
	Use e-portfolios for assessment	IP2G11I	
	Use ICT to develop authentic (real-life) assignments for students	IP2G11J	
	Assess students' [computer and information literacy]	IP2G11K	
			Recoding
	1 = Expected and required	1	1
	2 = Expected but not required	2	0
	3 = Not expected	3	0

Description:	Expectations for teacher collaboration using ICT		
Source:	Are teachers in your school expected to acquire knowledge and skills in each of the following activities?		
	Collaborate with other teachers via ICT	IP2G11D	
	Communicate with parents via ICT	IP2G11E	
	Communicate with students via ICT	IP2G11F	
			Recoding
	1 = Expected and required	1	1
	2 = Expected but not required	2	0
	3 = Not expected	3	0

Description:	Priorities of increased ICT resources		
Source:	At your school, what priority is given to the following ways of facilitating the use of ICT in teaching and learning?		
	Increasing the numbers of computers per student in the school	IP2G15A	
	Increasing the number of computers connected to the Internet	IP2G15B	
	Increasing the bandwidth of Internet access for the computers connected to the Internet	IP2G15C	
			Recoding
	1 = High priority	1	1
	2 = Medium priority	2	1
	3 = Low priority	3	0
	4 = Not a priority	4	0

Description:	Priorities of increased ICT professional learning resources		
Source:	At your school, what priority is given to the following ways of facilitating the use of ICT in teaching and learning?		
	Increasing the range of digital learning resources available for teaching and learning	IP2G15D	
	Establishing or enhancing an online learning support platform	IP2G15E	
	Supporting participation in professional development on pedagogical use of ICT	IP2G15F	
	Increasing the availability of qualified technical personnel to support the use of ICT	IP2G15G	
	Providing teachers with incentives to integrate ICT use in their teaching	IP2G15H	
	Providing more time for teachers to prepare lessons in which ICT is used	IP2G15I	
	Increasing the professional learning resources for teachers in the use of ICT	IP2G15J	
			Recoding
	1 = High priority	1	1
	2 = Medium priority	2	1
	3 = Low priority	3	0
	4 = Not a priority	4	0

C.3 School ICT coordinator survey

Description:	Availability of ICT technology resources at school		
Source:	Please indicate the availability of the following technology resources in your school.		
	Digital learning resources that can be accessed offline	II2G04A	
	Digital learning resources that can only be used online	II2G04B	
	Access to the Internet through the school network	II2G04C	
	Access to an education site or network maintained by an education authorities	II2G04D	
	Email accounts for students	II2G04E	
			Recoding
	1 = Available to teachers and students	1	1
	2 = Available only to teachers	2	0
	3 = Available only to students	3	0
	4 = Not available	4	0

Description:	Availability of ICT software resources at school		
Source:	Please indicate the availability of each of the following software resources at your school.		
	Practice programs or [apps] where teachers decide which questions are asked of students (e.g. [Quizlet, Kahoot], [mathfessor])	II2G05A	
	Single user digital learning games (e.g. [languages online])	II2G05B	
	Multi-user digital learning games with graphics and inquiry tasks (e.g. [Quest Atlantis])	II2G05C	
	Word-processor software (e.g. [Microsoft Word®])	II2G05D	
	Presentation software (e.g. [Microsoft PowerPoint®])	II2G05E	
	Video and photo software for capture and editing (e.g. [Windows Movie Maker, iMovie, Adobe Photoshop])	II2G05F	
	Concept mapping software (e.g. Inspiration®], [Webspiration®])	II2G05G	
	Data logging and monitoring tools (e.g. [Logger Pro]) that capture real-world data digitally for analysis (e.g. speed, temperature)	II2G05H	
	Simulations and modelling software (e.g. [NetLogo])	II2G05I	
	A learning management system (e.g. [Edmodo], [Blackboard])	II2G05J	
	Graphing or drawing software	II2G05K	
	e-portfolios (e.g. [VoiceThread])	II2G05L	
	Digital contents linked with textbooks	II2G05M	
	Social media (e.g. [Facebook, Twitter])	II2G05N	
			Recoding
	1 = Available to teachers and students	1	1
	2 = Available only to teachers	2	0
	3 = Available only to students	3	0
	4 = Not available	4	0

Description:	Availability of ICT resources at target grade		
Source:	Please indicate the availability of the following technology facilities at [target grade]		
	Remote access to a school network	II2G06A	
	Space on a school network to store files	II2G06B	
	A school intranet with applications and workspaces	II2G06C	
	Internet-based applications for collaborative work (e.g. [Google Docs®])	II2G06D	
	A learning management system (e.g. [WebCT®],[Moodle])	II2G06E	
	A 3D printer	II2G06F	
	Robots or robotic devices	II2G06G	
	Access to a wireless LAN (Wi-fi)	II2G06H	
			Recoding
	1 = Available to teachers and students	1	1
	2 = Available only to teachers	2	0
	3 = Available only to students	3	0
	4 = Not available	4	0

Description:	Computer resource hindrances to the use of ICT in teaching and learning		
Source:	To what extent is the use of ICT in teaching and learning at your school hindered by each of the following obstacles?		
	Too few computers with an Internet connection	II2G13A	
	Insufficient Internet bandwidth or speed	II2G13B	
	Not enough computers for instruction	II2G13C	
	Lack of sufficiently powerful computers	II2G13D	
	Problems in maintaining ICT equipment	II2G13E	
	Not enough computer software	II2G13F	
			Recoding
	1 = A lot	1	1
	2 = To some extent	2	1
	3 = Very little	3	0
	4 = Not at all	4	0

Description:	Pedagogical resource hindrances to the use of ICT in teaching and learning		
Source:	To what extent is the use of ICT in teaching and learning at your school hindered by each of the following obstacles?		
	Insufficient ICT skills among teachers	II2G13G	
	Insufficient time for teachers to prepare lessons	II2G13H	
	Lack of effective professional learning resources for teachers	II2G13I	
	Lack of an effective online learning support platform	II2G13J	
	Lack of incentives for teachers to integrate ICT use in their teaching	II2G13K	
	Restricted access to useful Internet resources	II2G13L	
	Insufficient technical ICT support	II2G13M	
	Insufficient pedagogical support for the use of ICT	II2G13N	
			Recoding
	1 = A lot	1	1
	2 = To some extent	2	1
	3 = Very little	3	0
	= Not at all	4	0

The IEA International Computer and Information Literacy Study (ICILS) Teacher Panel is an international comparative study that investigates changes in the use of information and communication technology (ICT) in schools before and during the global pandemic. The ICILS Teacher Panel marks the first time in 40 years that IEA has conducted a panel study and collected longitudinal data. Building on ICILS as the baseline, the panel study collected longitudinal data on computers and technology use in education from school principals, ICT-coordinators, and teachers, in Denmark, Finland, and Uruguay.

The ICILS Teacher Panel explores differences among and within countries in the changes of ICT-related resourcing within schools and responses to issues such as, respondents' attitudes towards technology, the use of ICT in teaching and learning, and whether social inequality in educational opportunity increased during the COVID-19 pandemic. Schools that participated in ICILS 2018 were asked to support the collection of data from the same individual teachers that participated in ICILS 2018. In addition, the currently serving principals and ICT coordinators from those schools were invited to complete questionnaires to collect school-level information.

The international report first describes the responses to the COVID-19-reated educational disruption in the participating countries at national level, followed by the analyses on changes in the use of ICT between 2018 and 2020, and changes in social inequality of educational opportunity. The report also provides a comprehensive account of the conceptual, methodological, and analytical implementation of the study. It details information on the methods and procedures including instruments and data collection, sample, computation of weights, and variance estimation. The results of the ICILS Teacher Panel will support policymakers and education systems to develop a better understanding of the effective use of information and communication technology in education to better support ICT-based remote teaching and learning.

IEA