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A Booster for Digital Instruction:

The Role of Investment in ICT Resources and Teachers' Professional Development

SUMMARY

Results from the IEA's International Computer and Information Literacy Study (ICILS) Teacher Panel show a general increase in the use of information and communication technology (ICT) for teaching after the COVID-19 outbreak. This brief examines how changes in the availability of school ICT resources and recent participation in ICT-related professional development may explain increases in teachers' use of ICT during the pandemic in Denmark, Finland, and Uruguay. Results indicate positive effects of both professional development and school ICT resources on ICT use in all three countries. The brief concludes with a discussion of recent policy efforts to promote the use of ICT through targeted investments in computer infrastructure and ICT-related teacher training. It also outlines the implications for future evidence-based responses to educational disruptions.

IMPLICATIONS

- Teachers' use of technology increased significantly during the pandemic, showing that the COVID-19 outbreak has been a watershed moment for the use of ICT for instructional purposes.
- Education systems can support teachers' use of ICT by ensuring they have sufficient resources available in their schools and adequate professional development activities focused on ICT use for teaching and learning.
- The importance of digital instruction for remote learning will persist beyond the pandemic, as other events, such as extreme weather conditions, natural hazards or armed conflicts, may require digital instruction.
- Education systems worldwide need robust evidence to better understand what facilitates teachers' use of ICT. In this way, they can introduce appropriate measures to increase ICT use.

International Association for the Evaluation of Educational Achievement (IEA), Amsterdam.

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INTRODUCTION

In early 2020, life and education as we knew it changed considerably. The arrival of the COVID-19 pandemic meant that schools, teachers, students, and parents had to adapt to a different mode of schooling. To slow the spread of the virus, schools around the world were closed for weeks, months, or even an entire school year, with many countries experiencing repeated school closures. It is estimated that more than 1.6 billion students have been affected worldwide (UNESCO, 2022).

The use of ICT was not the norm

Under these challenging circumstances, teachers were expected—more than ever—to use information and communication technology (ICT)¹ to continue teaching. However, educational systems faced very different conditions, not only in terms of ICT infrastructure and resources, but also in students’ and teachers’ readiness for digital schooling and in the use of ICT for teaching and learning. For example, while ICT has gradually become more important for teaching and learning in recent decades, many teachers were still not integrating ICT into their everyday teaching prior to the COVID-19 pandemic. In fact, in the IEA’s International Computer and Information Literacy Study (ICILS) 2018, only half of the teachers reported using ICT to teach every day (Fraillon et al., 2020).

To increase the use of ICT for teaching and learning during the pandemic, many countries implemented various measures and programs to improve the availability of ICT resources and to provide additional ICT-related professional development training to teachers. For example, digital teacher training

programs were launched in several countries to support teachers in the use of video communication programs, and teachers reported that schools provided them with infrastructure to support remote teaching (Meinck, Fraillon, & Strietholt, 2022).

Need for evidence on the determinants of ICT use

Do investments in ICT infrastructure and training effectively promote the use of computers for learning and teaching? Demands for the increased use of digital instruction across the world have made it more urgent to understand the determinants of ICT use for teaching and learning. In this regard, recent comparative research is unclear on whether ICT resources and professional development training increase ICT use in teaching (e.g., Drossel, Eickelmann & Gerick, 2017; Konstantinidou & Scherer, 2022). Furthermore, earlier studies have important limitations—they describe the situation before the pandemic and use cross-sectional data, making it prone to confounding biases.

In this brief, we examine the role that changes in the availability of ICT resources (i.e., investments) and teachers’ participation in professional development play in explaining changes in teachers’ use of ICT for teaching and learning before and during the pandemic. Specifically, this brief addresses the following questions:

1. Did teachers’ use of ICT for teaching and learning increase during the pandemic?
2. Were investment in ICT resources and ICT-related professional development training positively related to changes in teachers’ use of ICT during the pandemic?



¹ In the present study, we define ICT as online communication technologies and learning platforms.

DATA

We use data from the ICILS Teacher Panel, an international comparative panel study that re-surveyed the same teachers that participated in ICILS 2018 again in 2020 (Strietholt, et al., 2021). Because the teachers were surveyed both before and after the COVID-19 outbreak, their responses provided a longitudinal perspective on ICT use and its possible determinants. The final samples of teachers who participated in both the 2018 and 2020 surveys consisted of 445 teachers from Denmark, 1246 teachers from Finland, and 468 teachers from Uruguay. This represents 40%, 67% and 36% of the baseline sample of teachers that participated in ICILS 2018, respectively. Non-response bias analyses carried out by the IEA show, overall, only few statistically significant differences between teachers participating in the panel and those that did not in all three countries.

We performed multiple regression analyses where our outcome is the *ICT Use* index that summarizes teachers' responses to a set of items on how frequently they use different digital learning tools in their lessons.

The two main explanatory variables were the indices *Professional Development* and *ICT Resources*. To measure professional development, we used teachers' responses from 2020, when teachers were asked how often they had participated in various training opportunities related to ICT in the last two years. The second index measures investments in *ICT Resources* based on teachers' statements on the ICT resources available to them in their schools. To determine investment between the two measurement points, we calculated the difference between 2020 and 2018. Table 1 shows the main variables of our analyses and the ICILS items used to create them.

In our regression models, we evaluate the association between the *ICT Use* in 2020 – our outcome variable – and our two main explanatory variables, and we account for a set of key control variables that were observed in 2018, including previous ICT use, self-efficacy, positive views about ICT, sex, and initial teacher education in ICT. This allowed us to not only essentially model the change in the *ICT Use* index but also to account for possible other confounding effects.

Table 1: Variables included in the statistical analysis of teachers' use of ICT

Index	Description	Items
ICT Use	<p><i>How often did you use the following tools in your teaching of the reference class this school year?</i></p> <p>1 = Never 2 = In some lessons 3 = In most lessons 4 = In every or almost every lesson</p>	<p>A learning management system (e.g. Edmodo, Blackboard) Communication software (e.g., email, direct messaging, Skype) Collaborative software (e.g. Google Docs®, Onenote) Padlet), e-portfolios (e.g. VoiceThread), Social media (e.g. Facebook, Twitter)</p>
ICT Resources ²	<p><i>To what extent do you agree or disagree with the following statements about the use of ICT in teaching at your school?</i></p> <p>1 = Strongly agree 2 = Agree 3 = Disagree 4 = Strongly disagree</p>	<p>My school has sufficient ICT equipment (e.g., computers). The computer equipment in our school is up to date. My school has access to sufficient digital learning resources (e.g., learning software or apps). My school has good connectivity (e.g., fast speed) to the Internet. There is sufficient technical support to maintain ICT resources.</p>
Professional Development	<p><i>How often have you participated in any of the following professional learning activities in the past two years?</i></p> <p>1 = Not at all 2 = Once only 3 = More than once</p>	<p>A course on ICT applications (e.g., word processing, presentations, internet use, spreadsheets, databases) A course or webinar on integrating ICT into teaching and learning Training on subject-specific digital teaching and learning resources A course on use of ICT for (students with special needs or specific learning difficulties) A course on how to use ICT to support personalized learning by students</p>

² Response categories were inverted for this index.

RESULTS

In the following, we will first compare changes in the average use of ICT. Then, we will present the results from regression analyses that examined whether investment in professional development and ICT resources was associated with ICT use in 2020.

ICT use increased considerably after the COVID-19 outbreak

A key finding of our analyses is that the use of ICT for teaching increased significantly in all three countries. Figure 1 shows the average ICT use reported by teachers in 2018 as a baseline indicator, along with the responses from 2020. The largest increase was observed in Uruguay, where ICT tools were used less frequently in 2018 than in Denmark and Finland.

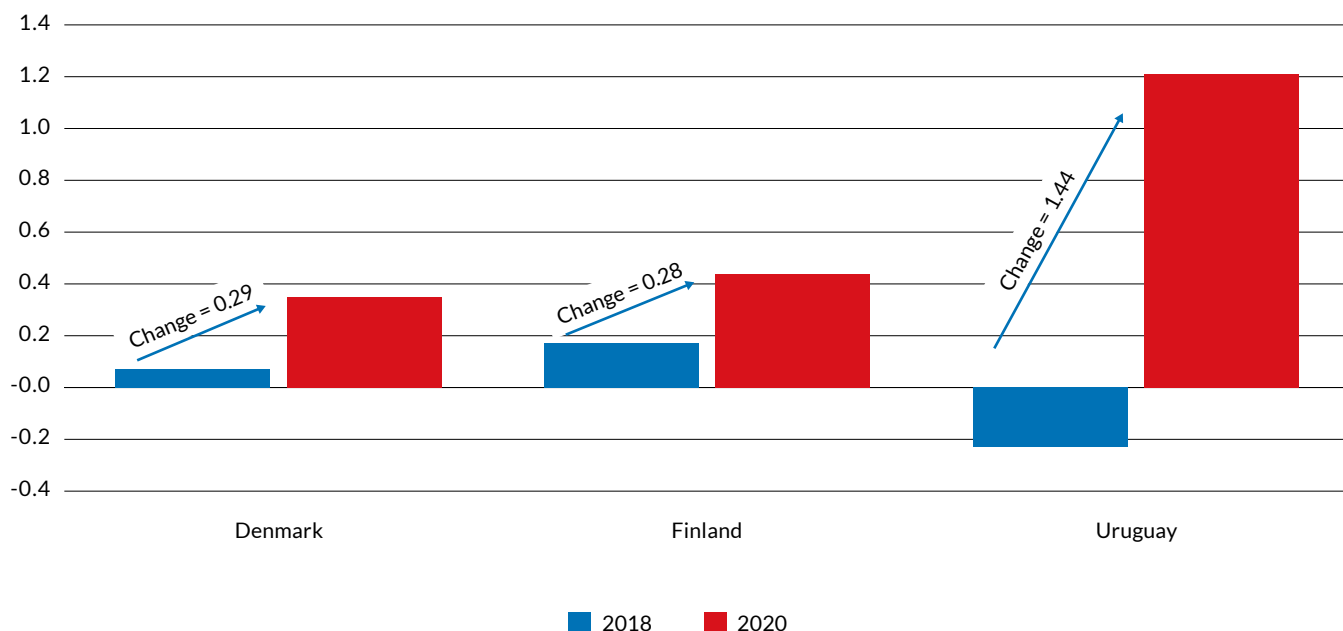
The ICT Use index was standardized to have an international mean of 0 with a standard deviation of 1 in 2018. Thus, the change of 1.44 observed in Uruguay corresponded to an increase of well over one standard deviation. The changes

were smaller in Denmark and Finland but still corresponded to about one third of a standard deviation.

Investment in school ICT resources and teachers' professional development boost digital instruction

We used regression analyses to study the role of changes in the availability of ICT resources and teachers' participation on professional development for the use of ICT for teaching and learning. While teachers had no other alternative but to increase their ICT use due to school closures, our results provide evidence that changes in ICT infrastructure and professional development were also related to increased ICT use. Table 2 shows the standardized estimated regression parameters for both explanatory variables, which are positive in all three countries. For example, the parameter for ICT resources suggests that a one standard deviation increase in ICT resources is associated with a 14% standard deviation increase in teachers' use of ICT in Uruguay.

Figure 1: Change in ICT Use between 2018 and 2020



Note: The ICT Use index was standardized to have an international mean of 0 with a standard deviation of 1 in 2018. All changes are significant at the 1% level.

Table 2: Panel Regression of Teachers' ICT Use in 2020 on ICT Resources and Professional Development

	ICT USE 2020		
	Denmark	Finland	Uruguay
ICT Resources	.09† (.06)	.06* (.02)	.14* (.06)
Professional Development	.09† (.06)	.09** (.03)	.14* (.06)
ICT Use 2018 Covariates	✓ ✓	✓ ✓	✓ ✓
N	399	1153	338

Note: Standard errors in parentheses; significance levels: ** $p < .01$, * $p < .05$, † $p < .10$, all one-tailed; covariates are self-efficacy, positive views about ICT, sex, initial teacher education in ICT, all observed in 2018.

DISCUSSION

The COVID-19 outbreak has proven to be a watershed moment for the use of ICT for instructional purposes, as the pandemic forced educational systems around the world to use technology to continue schooling. For many countries, the pressure to continue to deliver the curriculum prompted a massive investment in ICT, including such things as the provision of laptops and connectivity in homes together with training for teachers. In this brief, we studied changes in the use of ICT for teaching after the COVID-19 outbreak in Denmark, Finland, and Uruguay. Although ICT use increased at the system level, not all teachers made equal use of ICT. After controlling for prior ICT use and other covariates, our analyses suggest that professional training during the pandemic and investment in school ICT resources were associated with increased ICT use.

The evidence presented in this brief suggests the availability of school ICT resources and the provision of appropriate teacher training in ICT use for instruction are key areas to be addressed by policymakers who wish to improve teachers' use of ICT for teaching and learning. These findings are stable in the three countries—even though they had very different levels of ICT integration prior to the pandemic. Although we used international data and the countries naturally had different levels of investments, our analyses provide robust

evidence for the effectiveness of ICT resources and teacher training for the use of ICT for learning.

Ensuring schools have sufficient and adequate ICT resources (including equipment, good connectivity but also technical support for teachers) seems to be a prerequisite for ICT use. However, if teachers do not know how to use them and how to successfully integrate them into their teaching, they might not be able to put these resources to use. Therefore, professional training programs targeting ICT use for teaching are important to support teachers in their continued use of ICT.

Finally, our analyses point to the merits of the investments made during the pandemic to expand ICT infrastructure and to train teachers in the use of ICT. The importance of digital learning goes beyond the current pandemic. Once the pandemic is over, other events such as extreme weather conditions, natural hazards or armed conflicts may prevent children from attending school buildings and classrooms, and, in these cases, ICT can enable learning to be continued remotely. Therefore, 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.

ABOUT THE AUTHORS

ANA MARÍA MEJÍA RODRÍGUEZ



Ana María Mejía Rodríguez is a researcher at the IEA's Research and Analysis Unit. Prior to joining the IEA in 2021, she was an Early-Stage Researcher of the European Training Network OCCAM. Her research interests include comparative analyses of educational systems using large-scale assessment data, educational effectiveness, and the dissemination of results beyond the core research audience.

ANDRÉS STRELLO



Andrés Strello is a researcher at the IEA's Research and Analysis Unit. Prior to joining the IEA in 2021, he was an Early-Stage Researcher of the European Training Network OCCAM. He is interested in educational inequality, sociology of education, and comparative analyses.

ROLF STRIETHOLT



Rolf Strietholt is the Co-Head of the IEA's Research and Analysis Unit (RandA). He coordinates research on educational measurement and consults external researchers and international organizations. His main research interests include school and educational effectiveness research and research methodology.

ANDRÉS CHRISTIANSEN

Andrés Christiansen is a researcher at the IEA's Research and Analysis Unit, where he is involved in scaling and secondary analyses of IEA data. Prior to joining the IEA, he worked for the Ministry of Education of Peru participating in educational effectiveness studies. His research interests include psychometrics, educational effectiveness, political psychology, and education inequality.



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The International Association for the Evaluation of Educational Achievement, known as IEA, is an independent, international consortium of national research institutions and governmental agencies, with headquarters in Amsterdam. Its primary purpose is to conduct large-scale comparative studies of educational achievement with the aim of gaining more in-depth understanding of the effects of policies and practices within and across systems of education.

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