



Pedagogical uses of ICT in Finnish and Chilean schools: A systematic review

Ángela Novoa-Echaurren ¹

 0000-0002-0694-9044

Alejandra Canales-Tapia ²

 0000-0001-6433-4366

Linda Molin-Karakoç ^{3*}

 0000-0002-7907-6993

¹ Universidad de Los Andes, Santiago, CHILE

² Holistik Educación e Innovación, CHILE

³ University College London, London, UNITED KINGDOM

* Corresponding author: linda.molin-karakoc.17@ucl.ac.uk

Citation: Novoa-Echaurren, Á., Canales-Tapia, A., & Molin-Karakoç, L. (2025). Pedagogical uses of ICT in Finnish and Chilean schools: A systematic review. *Contemporary Educational Technology*, 17(1), ep561. <https://doi.org/10.30935/cedtech/15828>

ARTICLE INFO

Received: 21 Aug 2024

Accepted: 19 Nov 2024

ABSTRACT

Rapid technological developments have heightened global interest in pedagogically sound uses of information and communication technologies (ICTs) in education. However, universal principles for ICT integration need to better align with the local realities of teachers and schools for optimal uptake. Using Chile and Finland as case studies, this research summarizes, appraises, and synthesizes literature on teachers' ICT uses before and during the pandemic. Adopting a 'glocal' framework (Manca et al., 2021), the study identifies local and global trends in ICT uses, including potential research shifts that carry implications for both theory and practice. A systematic literature review was conducted to examine Finnish and Chilean teachers' ICT uses as reported in studies across five databases. The search was limited to peer-reviewed, English-language publications over a thirteen-year period and yielded 26 high-quality papers that were analyzed using meta-aggregation. Findings reveal that the reported ICT uses depended on the research methods employed to study these where qualitative studies documented innovative uses and quantitative studies more traditional uses of ICT. During the pandemic, research shifted to focus more on teacher experiences with Finnish studies highlighting positive ICT-related experiences and Chilean studies negative experiences including teachers' lack of training and practical issues. Based on the findings, recommendations are given to continue to enhance ICT integration both locally and globally.

Keywords: ICT integration, pedagogical uses of ICT, systematic literature review, COVID-19 pandemic, Finland, Chile

INTRODUCTION

The rapid growth in digital technologies has increased interest and pressure on their pedagogical integration into education. While several theoretical and practice-oriented frameworks (Crompton & Burke, 2020; Koehler et al., 2013; Laurillard, 2012) have been introduced to aid the pedagogically sound adoption of information and communication technologies (ICTs), the plethora of existing approaches and terms used (e.g., ICTs, digital technology, digital devices, media) reflects the dynamic nature of ICTs and sound ICT integration (Livingstone, 2012). As a result, what is 'pedagogical' in the pedagogical uses of ICTs continues to cause debate concerning theories of technology-enhanced learning and possible contextual factors influencing technology

An earlier version of this paper has been presented at the IAFOR European Conference on Education, 2023 by the first author.

use among teachers (Bond et al., 2019; Tondeur et al., 2017). This complexity is frequently overseen in research on ICT integration in education, yet complicates questions of 'why', 'what for', and 'how' digital technologies should be adopted.

As opposed to decontextualized frameworks, a dynamic view of ICT integration suggests that appropriations of digital resources for teaching and learning must happen in concert with educational needs and goals on the ground. In this paper, we propose adopting a 'glocal' approach (Manca et al., 2021) for a more encompassing view of ICTs to grasp 'pedagogy' and harness the full potential of technology-mediated interactions. According to this view, using ICT 'pedagogically' has less of a universal character and is more dependent on the socio-political, educational, or cultural contexts¹ in which technologies are applied (Selwyn, 2022; Williamson et al., 2020).

Given the exponential growth in digital technology use and ICT infrastructures in education in the past three decades, including remote teaching carried out during the COVID-19 pandemic, our interest lies in how teachers' pedagogical uses of ICT have been approached in research studies in different countries in recent years. With similar paths in ICT infrastructure yet divergent teacher training and support for ICT uptake, in this study, we confine ourselves to the educational contexts of Chile and Finland. Both countries have undergone similar pushes for digital learning at school (Claro et al., 2018; Ibieta et al., 2017; Lavonen, 2020; Sipilä, 2014), including mutual initial teacher training research initiatives (Meisalo et al., 2010). Additionally, global challenges faced by the countries during the pandemic, including locally articulated needs for synergies between pedagogical theories, educational policies and practical uses of ICTs make the two nations comparable for analysis. A comparative study can thus identify what uses of ICT have been reported, exploring possible changes in teachers' pedagogical uses of ICTs before and during the COVID-19 pandemic in the two countries. In investigating ICT integration in the two contexts, our study focuses on primary and secondary education, the formative schooling years for many children.

Few studies have focused on comparing ICT uses in the two nations, and more information is thus needed regarding how pedagogical uses of ICT are approached and/or how research (or policies) has been translated into ICT practices in the two countries. The present study aims to answer the following research questions (RQs):

RQ1: How have 'pedagogical' uses of ICTs been reported or approached in Finnish and Chilean educational research?

RQ2: What do research studies from Finland and Chile reveal about possible changes in 'pedagogical' ICT uses (or conceptualizations thereof) before and during the pandemic?

A systematic review methodology was adopted for the study (Aromataris & Munn, 2020; Lockwood et al., 2020) and a qualitative, meta-aggregative analytical approach (Tondeur et al., 2017) was applied to summarize, appraise and synthesize pertinent research studies on the topic. Furthermore, a 'glocal' view of technology adoption was used as a framework for the study. The results revealed novel insights into less scrutinized areas in educational technology research such as the role of research methodologies for reporting on local applications of technology and implications of current portrayals of ICT integration for integrating research and practice in the everyday ICT uses of Finnish and Chilean teachers.

This paper has been organized to review approaches taken to ICT integration in the two countries. It begins with an overview of current literature, including a discussion of key concepts and the study's theoretical framework. It then introduces the methodology, analytical methods, research process and activities. This is followed by a presentation of findings, including synthesized themes and relevance for answering the RQs. Lastly, the paper discusses implications, including study limitations and recommendations for future research.

¹ Selwyn (2022) states that context has been defined differently in edtech research. In this paper, we view context as a set of agreements and norms related to any educational institution's organizational culture. It contains multiple layers, going from a single teaching and learning experience to broader influences on institutional experiences such as family, national policymakers or society at large.

LITERATURE REVIEW

Pedagogical Uses of ICT

A common interpretation of ICT use in education is that advancements in technological devices, software, and applications have transformed what is meant by teaching and learning. According to this view, new technological developments have blurred boundaries between digital and non-digital, offline and online, necessitating new perspectives and frameworks to guide ICT use among teachers (Crompton & Burke, 2020; Kennedy & Laurillard, 2023). To help teachers embrace new developments, theories presented by educational technology scholars have aimed to support educators in integrating digital resources and services into classroom settings through frameworks such as TPACK (Koehler et al., 2013), SAMR (Crompton & Burke, 2020), the conversational framework (Kennedy & Laurillard, 2023), user-generated contexts (Dourish, 2017; Luckin, 2018), the visible learning (Hattie, 2023), and educational change (Azorín & Fullan, 2022).

Providing teachers with theoretical assistance regarding decisions around ICT has been envisaged as providing a universal and often linear path to pedagogically informed uses (e.g., Crompton & Burke, 2020; Koehler et al., 2013). However, many of the currently employed frameworks fail to address localized needs of ICT use (Manca et al., 2021). Accordingly, following generic frameworks may lead to overlooking profound questions of 'why', 'how' or 'what for' certain digital technologies are promoted or used (Selwyn, 2022). Hence, rather than embracing technologies uncritically, a more practical line of thinking revolves around how particular devices affect student learning and the achievement of educational goals locally which helps optimize uses of technology according to specific learners and contexts.

Traditional versus innovative uses of ICT

Educational technology research often juxtaposes traditional, teacher-centric ICT use focused on content delivery with innovative ICT practices, aimed at student engagement, experiential learning, and collaboration (OECD, 2009; Prestridge, 2017; Väättäjä & Ruokamo, 2021). Depending on local needs, Laurillard et al. (2018) argue that technology can support various learning modalities, enriching student experiences. Although innovative approaches are seen as more effective for authentic learning (Fullan & Langworthy, 2014), a mix of traditional and innovative methods may hence be necessary to address diverse learners' needs and, as discussed below, socio-cultural contexts of education.

Contextual factors affecting teachers' integration of ICT

Optimal forms of digitally enhanced education are sometimes considered universal. Nonetheless, the nature of teaching and learning is contingent upon instructional contexts (Turvey & Pachler, 2018; Williamson et al., 2020). Context-related factors that shape teachers' uses of ICTs include but are not limited to:

- (a) each pupil's learning needs (Webb, 2014),
- (b) teachers' pedagogical beliefs (Tondeur et al., 2017),
- (c) teachers' digital literacies (Lankshear & Knobel, 2015; Potter & McDougall, 2017), including knowledge of technology affordances (Oliver, 2013), and
- (d) time and support for ICT take up (Crook et al., 2010; Michos et al., 2018), i.e., professional development (PD) opportunities, access to technology and connectivity.

Given such contextual factors and their role in planning a sustainable and enriching education, any irreflexive incorporation of technologies into school systems should be questioned. In this light, Selwyn (2022, 2023) discusses 'technological essentialism' and contends that technocentric notions can lead us to fall into naïve assumptions that ICT is inherently good or convenient in all contexts. This is often illustrated in situations where educational technology is posited as a 'one-size-fits-all' solution rather than a problem (Selwyn, 2023). As a result, more priority should be given to supporting teachers both theoretically and practically in 'how' select technologies can be integrated and 'why' as technocentric thinking has been linked to a deficiency in teachers' capacity to integrate ICTs successfully (Selwyn, 2022).

Given the rapid development of digital technology, policies and practices at the school level often lag behind advances in ICT research and theories of knowledge and learning (Claro & Jara, 2020; Lowyck, 2013).

Increasing time and support for teachers in finding, selecting and experimenting with new technologies and new ideas for digital technology-related educational goals could strengthen the transfer of knowledge and promote more effective ICT use among teachers as applied to their classroom setting. Rather than focusing on universal principles or only locally suitable practices, exploring the phenomenon through a 'glocal' lens could therefore be seen to lead to a nuanced understanding of how broad technological trends can be adapted to meet local, diverse educational needs and contexts, fostering more contextually relevant and effective decision-making and implementations.

The Current State of ICT Integration in Chilean and Finnish Education

The Finnish context

Over the last thirty years, Finland has made substantial investments in the ICT infrastructure of its schools to maintain a competitive global educational force (Niemi et al., 2013). As an innovative and technology-rich society (Kaarakainen & Saikkonen, 2021; Lavonen, 2020), Finland has prioritized digital learning and emerged as a frontrunner in ICT integration in the early 2000s (see Kankaanranta, 2009; Kozma, 2008). However, early ICT integration attempts were project-oriented, institution-based initiatives, often peripheral and short-term, raising the need to evaluate the effectiveness of ICT integration at a national level (Niemi et al., 2013). In 2010, a report released by the Finnish Ministry of Education (2010) revealed that the rate of technology use in Finnish classrooms was average by European standards and ranked lowest among Nordic countries.

Since then, ambitious policy initiatives and funding have aimed at transforming Finland into a digital 'superpower', yet expected outcomes are far from realized. The antecedent triggered new reform initiatives and school curricula focusing on digital education in 2014–2016 (EUN, 2017; Lindberg, 2022). Recently, efforts have been made to enhance ICT integration, support students' transversal skills, and address inconsistencies in teachers' ICT practices. With digital learning holding a central place in the national curriculum, several initiatives have been started to assist teachers (e.g., digital tutors, Majakka network), intending to help teachers navigate ICT-related challenges, and according to some researchers, efforts have succeeded to some extent (Lavonen, 2020; Sothayapetch & Lavonen, 2022). However, research also indicates that there are still significant variations in the degree to which ICT is used across Finnish schools (e.g., Kaarakainen & Saikkonen, 2021). Varied access to technology, school cultures and teacher beliefs are challenges regarding ICT uses, and as a decentralized system, teachers have the autonomy to decide whether to use ICT or not. More research has therefore been suggested to establish common ICT practices in the country (Lavonen, 2020).

The Chilean context

Like Finland, the Chilean education system has garnered attention owing to notable advancements in educational infrastructure and ICT training in the past decades. These achievements can be attributed primarily to a public policy initiative known as 'The Education and Technology Center of the Chilean Ministry of Education', Enlaces, created to improve the quality of education (Claro & Jara, 2020). Between the 1990s and 2020, the Enlaces network promoted teachers' use of ICTs by improving infrastructure, increasing connectivity, and offering PD and technical support to state-funded institutions. ICT integration has been a deliberate outcome of planned national policies prompted by the Enlaces network, and whilst undergoing reforms in 2020 transforming into the 'Center for Innovation in Education', the program still nominally exists today. Reforms undergone by Enlaces nevertheless implied the end of policies associated with its creation and development throughout the past three decades (Claro & Jara, 2020).

The end of Enlaces can be attributed to various factors, including the need for more alignment between specific organizational policies and teachers' current conditions for integrating ICTs. Despite significant progress in equipping schools with the necessary infrastructure, more substantial learning and professional uses of ICTs in Chilean schools are needed (Claro & Jara, 2020). Sánchez et al. (2011) contend that the achievements of Enlaces were not sustained by 2010 due to a narrow focus on training outside teachers' instructional contexts, hindering their ability to adjust ICT to specific conditions of schools and classrooms. At the same time, comparative studies between Chile and neighboring countries suggest that Chile has made significant progress in integrating ICT into classrooms, primarily due to long-term policies pursuing such a purpose (Salinas et al., 2017). The diversification of Enlaces' initiatives has posed challenges in establishing a

clear institutional vision for ICT use, focusing on technical rather than pedagogical aspects (Claro & Jara, 2020). Similar to the Finnish case, there is a need for increased reciprocity between ICT use, selection, and adaptability of policies to aid teachers.

Shared observable patterns in educational policies on ICT use are evident between the two countries. For a long time, both countries have sought to address ICT integration in education, even if paths towards this goal have differed according to each country's educational system. Challenges for teachers have thus been due primarily to contextual specificities. In Finland, ICTs are an integral part of the curriculum, yet the decentralized nature of the system makes it challenging (and optional) for teachers to enact ICT-enhanced teaching practices. In Chile, national-level initiatives and isolated professional learning are critical issues. The latter has meant a focus on technical aspects of technology, detached from classroom contexts, making it difficult for teachers to utilize ICT meaningfully within everyday environments. The gap between well-intended educational ICT policies and teachers' everyday practices is discernible in both locations. As discussed in the findings, this gap appears more complex and pronounced in Chile than in Finland.

THEORETICAL FRAMEWORK

Research attempting to incorporate global or essentialist principles of ICT use into local settings has often done so with limited results (Chanpet et al., 2020; Cook et al., 2019). According to Selwyn (2023), progressing into the 2020s, it makes little sense to continue to suggest that intense digitization of education somehow offers a path to universal improvements, flourishing and progression toward 'better' forms of education, calling for a critical approach. This situation has prompted us to adopt a 'glocal' approach to integrating ICT (Barker et al., 2013), where the multiple factors accompanying ICT integration are highlighted. In light of the complex factors previously discussed, the relevance of a 'glocal' approach is growing, seeking to address, for instance, the current imbalance and disparity between global decisions and local needs and perspectives on ICT use (Barker et al., 2013).

Unlike decontextualized frameworks that uncritically guide ICT integration in education, a 'glocal' approach seeks to merge global perspectives with local contexts, optimizing digital technology adoption. This approach balances more universal, global theories and trends in educational technology with the unique cultural, institutional, and societal needs of local environments, thereby offering more sustainable models and actions (Manca et al., 2021). Rather than treating digital technology as a one-size-fits-all solution, a critical 'glocal' perspective allows for the customization of evidence-based strategies. It ensures the relevance of digital learning practices when specifically tailored to the needs of particular educational systems and communities (Selwyn, 2023). In doing so, a 'glocal' approach promotes a flexible yet informed adoption of digital technology, ensuring scalability while remaining sensitive to local educational contexts.

A 'glocal' approach further emphasizes the importance of interdisciplinary and cross-cultural methodologies in ICT integration. As Manca et al. (2021) highlight, the term 'glocal'—think globally, act locally—underscores the importance of contextualizing findings within specific cultural and institutional frameworks, which could help uncover research gaps, for example, a limited focus on digital skills development or the need for longitudinal data to guide a more holistic understanding of ICT integration and its development in educational systems. A 'glocal' approach likewise highlights the necessity for higher education institutions to collaborate internationally and innovate through shared knowledge, which can meet the evolving demands of research knowledge on digital learning in a globally interconnected educational landscape (Farias-Gaytan et al., 2023; Manca et al., 2021).

A 'glocal' perspective can overcome current mismatches between research and practice as this framing encourages the examination of ICT integration from multiple viewpoints. As such, it enables the identification of key patterns and trends in various contexts, including digital technology uses that could be considered 'pedagogically' sound (Farias-Gaytan et al., 2023). Allowing for cross-institutional, cross-cultural comparisons could offer additional insights into shared challenges, including strategies used to address current issues of a more global nature. It situates local digital technology use within a broader network of care, solidarity, and aid regarding technical and emotional support where, as Selwyn (2023) points out, technology becomes a shared pleasure and problem for a community of researchers and teachers rather than an individual teacher's, school's or nation's responsibility as frequently portrayed in educational technology studies.

Using a 'glocal' framework, the present study thus scrutinizes ICT uses among teachers in Chile and Finland, as reported by research in the two contexts. A 'glocal' perspective is seen as enriching for a cross-contextual study of ICT integration, deepening our understanding of how teachers can better adapt to technological advancements while impacting pedagogical models and digital learning outcomes (Manca et al., 2021).

METHODS

A systematic review methodology (Aromataris & Munn, 2020; Lockwood et al., 2020; Tondeur et al., 2017) and a meta-aggregative approach were used in the present study to extract and analyze data from existing research studies, comprising primarily journal articles. Qualitative and quantitative studies were analyzed to distil findings about ICT uses among teachers in the two countries. The data was organized into themes and categories and funneled into two synthesized statements. Similar statements are readily evident from a single study; hence the reduction process involved aggregating findings from multiple studies. Following Tondeur et al. (2017), we used the following criteria for our meta-aggregation:

- (a) critical interpretation of the phenomenon investigated,
- (b) transparency of the synthesis approach, and
- (c) significance for research and practice of the synthesized statements.

The research process was initiated in early 2020 when the researchers met to discuss the needs and aims of a comparative review of ICT integration in the two countries. Following this, the research team established a systematic review protocol and theoretical articles related to ICT integration were read and discussed, including previous systematic reviews on the topic. Drawing insights from the publications (including theoretical and empirical gaps), inclusion/exclusion criteria and methodological approach were decided. After defining RQs, the team agreed upon specific keywords (see the list of keywords strings in [Table 1](#)). Each team member then performed a literature search using a set of keywords and predefined databases. To optimize the search, Boolean operators (e.g., AND, OR, NOT, and *) were utilized as illustrated in [Table 1](#).

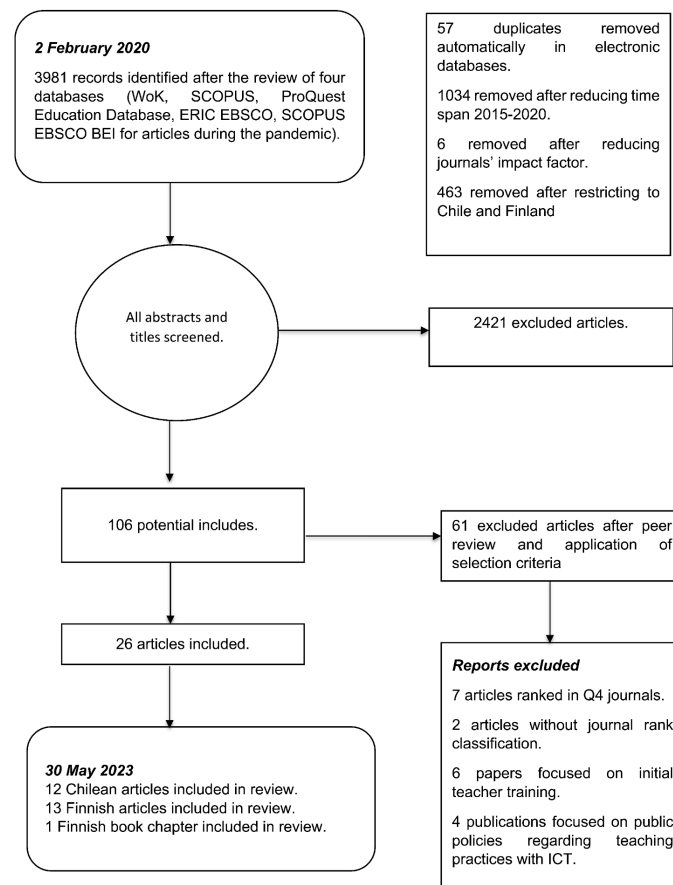
Table 1. List of terms used in databases

S/N	Search terms
1	'Teaching practice' AND 'ICT' AND 'Secondary'
2	'Teaching practice' AND 'ICT'
3	'Teaching practice' AND 'digital technolog*'
4	ICT AND Teach*
5	ICT AND Teaching OR Pedagogy
6	'Educational Technology' AND Pedagogies OR 'Teaching Practices' AND K-12 AND COVID-19
7	'Educational technology' AND Covid-19 AND 'Emergency Remote Teaching' AND K12 OR 'Primary Education' OR 'Secondary Education'
8	'Digital Technologies' AND Covid-19 AND 'Emergency Remote Teaching' AND K12 OR 'Primary Education' OR 'Secondary Education'
9	'Digit* Technolog*' AND Covid-19 AND 'Emergency Remote Teaching' AND K12 OR 'Primary Education' OR 'Secondary Education'
10	'Educational Technologies' AND 'Teach* practice*' AND 'Emergency Remote Teaching' OR 'Emergency Remote Education'
11	Covid-19 OR Coronavirus OR Pandemic AND 'Educational disruption'
12	Covid-19 OR Coronavirus OR Pandemic AND 'Emergency Remote Teaching'
13	Covid-19 OR Coronavirus OR Pandemic AND 'Emergency Remote Education'
14	Covid-19 OR Coronavirus OR Pandemic AND 'Public Health Emergency'
15	Covid-19 OR Coronavirus OR Pandemic AND 'Political Unrest'
16	Covid-19 OR Pandemi* OR Pandemic AND 'Political Unrest'
17	AND Finland OR Chile AND Finnish OR Chile

Four databases were initially deployed when searching for publications (WoS, Scopus, ProQuest Education Database, and ERIC/EBSCO) to ensure the location of adequate research material. However, a fifth database (EBSCO British Education Index) was soon added to retrieve more high-quality sources. After initial appraisal,

Table 2. Inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
Published 2010–2023	Published before 2010
English language (to enable peer review)	Not in English (to enable peer review)
School education (including K-12 and PK-12)	Not school education
Indexed in WoS, Scopus, ProQuest Education Database, ERIC, and EBSCO	Not indexed in these databases
Classified under Q1 and Q2 journal rank	Classified under Q3 or Q4 journal rank
Focus on uses of ICT	Other emphases related to educational technology but not specific to teaching practices

**Figure 1.** PRISMA flow diagram (Source: Adapted after Zawacki-Richter et al., 2019, p. 7)

to ascertain the rigor and soundness of studies, only studies from high-quartile/index factor publications were selected for inclusion and further review.

Additional inclusion and exclusion criteria were applied to maintain a high quality of publications. Publication dates were narrowed down to 2010–2023 to retrieve studies that focused on more recent educational integration and development of ICT. Moreover, only English-language publications were considered to enable each team member's independent review of the studies. Exclusion was furthermore applied to grey literature, i.e., conference proceedings, unpublished works, or articles not indexed in select databases as such papers have not undergone rigid peer review systems. The complete list of inclusion/criteria is seen in [Table 2](#).

The analysis of research materials started by removing duplicates and screening titles and abstracts for inclusion/exclusion. After finding potential inclusions, each researcher independently read and assessed the retrieved articles. Following this, the research team met, presented their selections and provided justification for the inclusion/exclusion of retrieved and selected papers according to pre-specified criteria. In case of disagreement between two researchers, the third researcher had the final say regarding the final inclusion of

a paper. One article dated before 2010 (Nussbaum et al., 2009) was included because of the significance of this piece in answering the RQ. [Figure 1](#) summarizes the review steps undertaken.

The review included a total of 26 research papers. For pre-pandemic studies (2010–2020), 13 articles and one book chapter satisfied predetermined criteria. For during-pandemic studies (2020–2023), 13 articles satisfied criteria. The final selection of papers is found in [Appendix A](#) and [Appendix B](#), respectively.

A meta-aggregative analytical approach was employed after finalizing the number of papers for the review. Selected articles were inductively coded for recurrent patterns or themes by dividing the retrieved papers between team members for individual coding. The papers were then switched for a second round of coding by a different team member. Undertaking dual coding enhanced coding reliability and a third team member then reviewed the two other team members' codes. All codes and themes were then discussed and agreed upon before aggregating them into synthesized statements. A description of the step-to-step analytical process is, as follows:

- (a) From the 26 studies, we selected codes and quotations that represented original findings on ICT uses. We compiled a list of codes and quotations from the pieces individually before meeting up to discuss recurrent codes.
- (b) Categorization of findings: We read/re-read the list of codes and quotations and jointly discussed what could be considered recurrent, central patterns or themes. Themes were then reduced into categories after thorough discussions. As a next step, categories were crystallized into syntheses or statements.
- (c) Synthesizing the categories: All three researchers reviewed and discussed categories again to distil further and synthesize the findings. 12 themes were reduced into 6 categories and 2 synthesized statements that revealed something new about the phenomenon under investigation in addition to recurrent patterns in research in the two contexts.

FINDINGS

The results have been divided into two parts. Synthesis 1 represents overall findings, and synthesis 2 represents findings from during-pandemic studies more specifically as revealed by our analysis. Both syntheses refer to research on ICT uses, answering the RQs posed:

- RQ1:** How have 'pedagogical' uses of ICTs been reported or approached in Finnish and Chilean educational research?
- RQ2:** What do the research studies from Finland and Chile reveal about possible changes in ICT use (or conceptualizations thereof) before and during the pandemic?

Reported ICT Uses Are Largely Influenced by the Methodology Used to Explore Them (Synthesis 1)

Our review found that quantitative investigations in both countries reported mainly traditional, teacher-centered technology uses (e.g., Claro et al., 2018; Ottestad, 2010), whereas qualitative studies disclosed more innovative teaching practices with ICT (e.g., personalized and collaborative learning) (e.g., Niemi et al., 2013; Vásquez et al., 2017). In other words, our analysis showed a connection between the types of pedagogical practices with ICT reported and methods of inquiry used in both Chilean and Finnish studies. The process of reaching this synthesized finding is illustrated in [Table 3](#).

Seen in category statements, articles from Finland revealed both teacher-centered ICT uses that emphasized content delivery (Ottestad, 2010; Sipilä, 2014) and learner-centered uses highlighting knowledge-building (Seitamaa-Hakkarainen et al., 2010; Vivitsou et al., 2016), collaboration and personalized learning (Niemi et al., 2013). Studies employing survey and statistical research documented more teacher-centered uses (Ottestad, 2010; Sipilä, 2014), whereas qualitative research (e.g., case studies and design-based research) reported more innovative, student-centered ICT use (Niemi et al., 2013; Seitamaa-Hakkarainen et al., 2010; Vivitsou et al., 2016). Using SITES data, Ottestad (2010) for example linked more traditional uses of ICT among Finnish teachers with greater autonomy in applying these technologies and more conservative attitudes among teachers. Ottestad (2010) however did not expand on the types of technologies or school contexts investigated, only three pedagogical orientations (traditional, life-long learning, and connectedness) were

Table 3. Synthesis 1

Examples of qualitative evidence	Theme no	Category no	Synthesis 1
"Also her confidence in using digital cameras with pupils had increased. In general, the experience had given her greater self-confidence to try out new things connected with teaching using digital technology" (Lakkala & Ilomäki, 2015, p. 9).	(1) In Finnish studies, emphasis on teachers' ideologies and/or confidence in teaching with ICT (Sipilä, 2014; Vivitsou et al., 2016).	(1) Survey studies report teacher-centered pedagogical uses of ICT such as content-delivery (e.g., Ottestad, 2010; Sipilä, 2014).	(1) The methodology used to study ICT use influences what ICT uses are reported.
"Schools that used ICT effectively based their work on activating learner-centered knowledge creation methods and practices. They had also made extra investments towards special needs students and have used ICT as a means to produce learning material for them" (Niemi et al., 2013, p. 63).	(2) Finnish publications reporting different types of ICT uses (Niemi et al., 2013; Ottestad, 2010).	(2) Case studies and design-based research showcase student-centered pedagogies, such as knowledge building (Niemi et al., 2013; Seitamaa-Hakkarainen et al., 2010; Vivitsou et al., 2016) and collaborative and personalized learning (Niemi et al., 2013).	
"The teacher and researchers planned the general theme of the project—Past, present and future of the artefact. We also agreed to put the emphasis on LCD/PI and integration of various school subjects" (Seitamaa-Hakkarainen et al., 2010, p. 115).	(3) Finnish research focusing on potential of teacher-researcher collaboration for more innovative, student-centered practices with ICT (Hämäläinen & Oksanen, 2014; Lakkala & Ilomäki, 2015).	(3) Surveys and tests measuring teachers' ICT competencies report teacher-centered ICT pedagogical uses such as teacher-student communication, use of ready-made materials, and content-delivery (Claro et al., 2018; Ibieta et al., 2017).	
"Our study focuses on factors at the individual level, particularly those associated with teachers such as their perceptions about ICT, self-confidence in the use of ICT, etc." (Ibieta et al., 2017, p. 427).	(4) Chilean research reporting factors influencing teachers' pedagogical uses of ICT.	(4) Case study reporting student-centered pedagogies, such as collaborative (Nussbaum et al., 2009; Vásquez et al., 2017) and personalized learning and metacognition (Vásquez et al., 2017).	
"TIDE capacity was defined as: The teacher's knowledge, skills, and attitudes for designing, organizing, guiding and evaluating activities with explicit learning objectives and teaching criteria, with a view to developing students' ability to solve information and communication problems in a digital environment" (Claro et al., 2018, p. 164).	(5) Chilean studies analyzing teachers' competencies in teaching with ICT.		
"The aim of this study is to therefore, first, to develop a self-paced learning strategy using formative assessment that shows significant learning gains; and then, using the established strategy, show if different platforms have an impact in learning when using this strategy" (Vásquez et al., 2017, p. 1145).	(6) Chilean studies focusing on the impact of interventions while employing ICT in teaching.		

associated with teachers' ICT use. Similarly, categorizing uses of ICT as either teacher-directed, student-directed or balanced, using a survey and large sample, Sipilä (2014) found evidence of largely teacher-directed uses of ICT among Finnish primary and secondary teachers where teachers spent most time on informative, evaluative, lesson planning and organizational uses of ICT. Like Ottestad (2010), Sipilä (2011), however, did not report what types of technologies were used, how or in what context.

Reporting on a qualitative study, Hämäläinen and Oksanen (2014) looked at how collaborative 3D games could supplement traditional educational practices, including enabling collaborative knowledge construction in secondary education through digital games. They concluded that while games contributed to high-level learning, teacher roles and agency in innovative ICT uses require more research. Similarly, Niemi et al. (2013) compared ICT uses among Finnish teachers through observations and interviews with school principals, illustrating qualitative case studies. They concluded that teachers who promoted innovative ICT uses came from school contexts where the institutional culture did not see technology as separate from context and sound teaching and learning, and promoted learner-centered knowledge creation, flexible and renewal-oriented local curricula and investment in communication across formal-informal learning environments. Presenting a wide range of technologies (e.g., media centers, distance education technology, digital portfolios,

films, digitalized notes and text messaging, and gap exercises using digital software and online environments), they reported multiple local approaches to technology.

Articles from the Chilean context revealed a similar prevalent emphasis on the scale or quantity of ICT use in research using survey studies and tests. In large-scale Chilean studies involving survey research and testing (e.g., Claro et al., 2018; Ibieta et al., 2017), except for Salinas et al. (2017), prevalent uses of ICT were linked to administrative tasks involving student-teacher communication the employment of pre-existing ICT resources (e.g., ready-made presentations and student worksheets) for content delivery. Ibieta et al. (2017) reported that teachers' most frequent activities with ICT include searching and preparing resources, supporting PD, and communicating with the school community. Approximately 90% of teachers searched the Internet for existing pedagogical resources, and 70% prepared presentations. Inside the classroom, 55% used ICT to present information, while 51% searched online for PD opportunities. This trend is also evident in Hinostroza et al. (2016). While focusing on quantifying technology use, a survey study by Salinas et al. (2017) took a slightly different perspective on ICT uses. Through an online survey of 332 mathematics teachers (76 from Chile, 147 from Ecuador, and 109 from Colombia), the study focused on the degree of technological understanding among teachers, ranging from 'awareness' (classified by them as the most basic), 'learning the process', 'understanding and application of the process', 'familiarity and confidence', 'adaptation to other contexts', and 'creative application to new contexts' (classified as the most sophisticated). The primary conclusion drawn from the study is that certain teachers are perceived to have gained the highest levels of ICT adoption by showing greater awareness of potential technology applications. The authors however cautioned that the sample is not representative of the general teacher population, comprising only teachers who voluntarily decided to participate.

Chilean research also encompassed case studies and design-based interventions, seeking to explore 'innovative' educational applications of ICT. Similar to the Finnish context, using more bottom-up approaches such as qualitative case studies (Nussbaum et al., 2009; Vásquez et al., 2017), innovative, student-centered practices with ICT in Chilean classrooms included harnessing digital technology to promote collaborative learning, metacognition, and personalized learning. For instance, Vásquez et al. (2017) reported two phases of self-paced learning with a formative assessment software using interpersonal computers with native Spanish-speaking students in state-subsidized schools. According to scholars, designing technology-assisted assessment requires tailoring of the formative component to student needs and selecting a technology platform that supports the desired teaching strategy. Following a similar design approach, Nussbaum et al. (2009) developed a design-based intervention in two Chilean schools featuring three secondary teachers, delving into 'technological scaffolding' to foster collaborative learning with pocket PCs. The notion of 'technological scaffolding' involved support provided by teachers to achieve collaborative learning outcomes. The authors concluded that ICT-mediated collaborative learning needed to foreground the role of the teacher more in the classroom ecology and that increasing teacher PD should be a prerequisite for the success of similar implementations.

ICT Uses and Teacher Experiences of Harnessing Educational Technology Are Contingent on National or Socio-Cultural Context and Support Systems (Synthesis 2)

The second synthesis found that research on teachers' uses of ICT changed during the pandemic giving more emphasis to teacher experiences. While changes and disruptions were much expected considering the global impact the pandemic had on schools, overall, we found that most Finnish investigations focused on sound pedagogical practices and positive learning gains during online teaching (e.g., Lager & Lavonen, 2023; Mankki & Rähä, 2022), whereas Chilean research concentrated on challenges of integrating digital technology during this period (Ávalos et al., 2022; Mateus et al., 2022; Saadati et al., 2021; Weinstein et al., 2022). The process of arriving at this finding has been elaborated in [Table 4](#).

Finnish research focused on how teachers could enhance the quality of instruction through digital technology use in this period reporting overall an increase in student-centered practices with ICT, including for instance more collaborative production (Lager & Lavonen, 2023), experiential learning (Loukomies & Juuti, 2021) and personalization (Lager & Lavonen, 2023; Mankki & Rähä, 2022). Loukomies and Juuti (2021) reported the use of video blogs to encourage fifth-grade pupils' reflections on emotions, and Lager and Lavonen (2023) investigated 16 upper-secondary students' collaborative learning practices, showcasing how

Table 4. Synthesis 2

Examples of qualitative evidence	Theme no	Category no	Synthesis 2
"(...) when distance teaching is designed carefully using adequate digital technologies, it can be highly effective in overcoming many of the traditional barriers to learning connected with space and time" (Mankki, 2022, p. 854).	(7) Finnish studies highlighted the relevance of teachers' deliberate and careful lesson plans, supported on a robust pedagogical framework, and sustaining permanent feedback through increased interaction.	(5) In Finland, student-centered pedagogical practices through remote teaching predominantly featured experiential (Loukomies & Juuti, 2021), collaborative (Lager & Lavonen, 2023), and personalized learning (Lager & Lavonen, 2023; Mankki & Rähä, 2022).	(1) Differences in teachers' experiences and uses of ICT relate to country context and support systems in place.
"The preconditions, such as teachers' and students' digital competences and the digital infrastructure necessary to switch to distance teaching and learning, have been recognized to be at an appropriate level" (Lager & Lavonen, 2023, p. 2).	(8) In Finland, prior investments in technological infrastructure positively affected the quality of remote teaching during lockdowns. (9) According to Finnish articles, teachers' professional development influenced positively teaching and learning outcomes during the pandemic. That is the case of teachers' and students' ICT competencies.	(6) In Chile, teacher-centered pedagogical practices through remote teaching primarily featured content delivery instruction (Cortés Abarca, 2021; Videla et al., 2022).	
"In terms of technical capacity teachers in both countries had some level of concern about their lack of software management knowledge, access to computer or tablet and inadequate internet connection" (Ávalos et al., 2022).	(10) According to Chilean studies, more preparation and support for teachers is needed to cope with the crisis, especially in terms of connectivity (Cortés Abarca, 2021), ICT competencies (Weinstein et al., 2022), and socio-emotional preparedness (Mateus et al., 2022).		
"Teachers have achieved high levels of resilience, but they demand that their states provide the role of bridging the existing gaps exacerbated by the pandemic through sustainable policies" (Mateus et al., 2022, p. 16).	(11) Chilean publications describe teachers' resilience and self-efficacy assessment to implement remote teaching during the pandemic.		
"Socioeconomic condition as the contextual limitations can prevent students from attending classes given the level of access to the technology or study conditions" (Saadati et al., 2021, p. 9).	(12) In Chile, socio-economic and geographic differences (e.g., between urban and rural locations) markedly yielded disparities in access to and quality of remote teaching and learning (Mateus et al., 2022; Saadati et al., 2021; Weinstein et al., 2022).		

pupils collaborated more and how teachers differentiated instruction more through ICT during the pandemic. Mankki (2022) argued that the success of online teaching practices among Finnish teachers lied in conscious and careful designs, where teacher autonomy coupled with a solid instructional structure, clear guidance, and feedback through interaction facilitated more student-centered teaching. At the same time, Sothayapetch and Lavonen (2022) highlighted difficulties in teachers' ICT uses, cautioning against over-optimism as teachers also faced challenges during the period of strictly online teaching. Two during-pandemic studies used surveys and questionnaires and four qualitative methods (interviews and vlogs), which indicates a trend of emphasizing contextual aspects of ICT use where teacher, student voices and school contexts intermingled more when describing ICT use.

Some articles from Finland documented a high level of preparedness among teachers to use digital technologies, leading to more positive experiences. References were made to years of educational policies

favoring teacher PD and solid ICT infrastructures that enabled an easier transition to online technologies during the pandemic (Lager & Lavonen, 2023; Lavonen, 2020). Lager and Lavonen (2023) for instance mentioned that preconditions for a successful move to online teaching were recognized; however, well-being among practitioners and school leaders also visibly decreased. Providing a similar perspective, Loukomies and Juuti (2021) and Sothayapetch and Lavonen (2022) also argued that teachers' responsiveness to ICT use in this period was appropriate primarily because of government-developed digital infrastructure and training.

Chilean teachers' use of ICT during the pandemic was mostly characterized as traditional and teacher-centered. Contrary to studies from Finland, Chilean studies collected evidence of the teachers' practices with technology primarily through surveys (Ávalos et al., 2022; Cortes Abarca, 2021; Saadati et al., 2021), questionnaires (Videla et al., 2022), with two studies incorporating focus groups (Mateus et al., 2022), and online interviews (Weinstein et al., 2022). Videla et al. (2022) reported that teachers mostly handed out worksheets or delivered videos for students to watch at home. They referred to 'traditional practices' as focusing exclusively on providing instructions, using formalisms and mechanization of functions.

During the pandemic, there was also more concern with teacher preparedness and conditions for online teaching in Chile, painting an overall pessimistic portrait of ICT use. Unlike Finnish studies, challenges were predominantly emphasized (Ávalos et al., 2022; Mateus et al., 2022; Saadati et al., 2021; Weinstein et al., 2022) in transitions from face-to-face to online teaching (Cortes Abarca, 2021). Articles highlighted for instance teachers' and students' limited ICT competencies (Cortes Abarca, 2021; Mateus et al., 2022; Saadati et al., 2021; Weinstein et al., 2022), limited Internet access due to socioeconomic status and geographic location as context-related factors that negatively influenced Chilean teachers' ICT use (Mateus et al., 2022; Saadati et al., 2021; Weinstein et al., 2022). Saadati et al. (2021) reported that when designing digital learning environments, Chilean teachers assumed a largely logistical and infrastructural role, acting as intermediaries between schools and families to monitor student ICT equipment and digital access. The study additionally found that students' socioeconomic conditions posed contextual limitations with unequal access to technology or unfavorable learning conditions. Other factors impacting Chilean teachers' pedagogical uses of ICT included a lack of socio-emotional support to facilitate emergency remote teaching (Cortes Abarca, 2021; Mateus et al., 2022; Weinstein et al., 2022). As such, the focus was mostly on practical matters and negative ICT-related experiences, while Finnish studies mainly emphasized positive experiences with strong national-level support.

DISCUSSION

From our systematic review, two key syntheses emerged regarding ICT use and the contextual differences and similarities between Finland and Chile. Synthesis 1 revealed that the methodological approach (qualitative vs. quantitative) used to study ICT uses was closely linked to the types of pedagogical practices reported (innovative vs. traditional). This resulted in the quantification of types of educational technology use among teachers without considerations for how or why they are used or qualitative explorations of contextual factors involved in sound applications of different technologies as related to a particular educational setting. The observed idiosyncrasies between research methodologies and ICT uses confirmed that educational technology research remains polarized and prone to dichotomous thinking (OECD, 2009; Prestridge, 2017). It overlooks the possibility of a broader spectrum of ICT uses, where both teacher-centered and learner-centered approaches can coexist as sound practices (Laurillard, 2012).

The divide in the reported ICT uses further highlights that quantitative studies on ICT integration often adopt global or universal principles advocating the necessity of teachers' ICT uses, while overlooking some key local factors or implications (Chanpet et al., 2020; Cook et al., 2019). This entails the portrayal of technology as a necessary 'good', fueling a technologically deterministic perspective where technology use is reduced to 'either-or', 'yes' or 'no' (Laurillard, 2012; Selwyn, 2022, 2023). Such an approach, when distinguished from teachers' everyday realities, can result in teachers limited ability to use technology effectively for their setting. In contrast, qualitative studies can more successfully illustrate 'how' specific technologies can be integrated and 'why' as relevant to the local context (Selwyn, 2022). At the same time, the transferability or upscaling of 'suitable' practices can be problematic when seeking to help teachers adopt technology in other contexts, as few generalized patterns or strategies often emerge from localized ICT practices. Based on our study, it appears that there is a greater demand for research-related information on cases and projects that

showcases local, contextualized ICT uses in Chile than in Finland. Meanwhile, in Finland, where education is decentralized and teacher autonomy high, more benefit could be derived from researching and applying more global principles and patterns to guide localized teacher uses of ICT.

The second synthesis reinforces earlier calls to avoid viewing ICT integration solely through decontextualized lenses. Reporting teachers' uses of ICT during the pandemic, this synthesis highlights the complex challenges teachers face when incorporating technology into teaching (Bond et al., 2019; Tondeur et al., 2017; Turvey & Pachler, 2018; Webb, 2014). Ensuring sufficient time, support for PD, and adequate technology infrastructure and connectivity (Crook et al., 2010; Michos et al., 2018) were more prominent concerns in Chile. The finding underscores the need for better alignment between research and practice in ICT integration, particularly to guide local teachers. In Chile, ICT policies and practices at the school level still tend to lag behind research advances and learning theories (Claro & Jara, 2020; Lowyck, 2013). In contrast, Finland provided more support to enhance teacher autonomy by applying global models during remote teaching, yet more reports are needed to showcase these ICT uses. Considering the creative uses of ICT by teachers during the pandemic in both countries studies reveal the need for multi-methodological, cross-contextual, and cross-cultural research on educational technology. Multiple factors influence how theoretical principles are applied in practice.

Synthesis 2 further demonstrated that teacher experiences of ICT integration changed during the pandemic where the country context and its available support systems mediated the research focus of ICT integration in this time period. Positive portrayals and innovations of ICT use in Finland indicated that a sound adoption of ICT use was mediated by the country's strong infrastructure and support system, attributed to renewed emphasis on ICT in the curriculum and years of teacher training (e.g., EUN, 2017; Lindberg, 2022). In contrast, Chilean studies highlighted challenges pertinent to contextual factors that impeded a smooth transition to during-pandemic online technology use. These factors were mostly practical and included issues like the Internet connectivity, ICT infrastructure, and student access to technology, hindering student-centered ICT implementation (Ávalos et al., 2022; Cortés Abarca, 2021; Saadati et al., 2021; Videla et al., 2022; Weinstein et al., 2022). It is also worth noting that school closures during the pandemic may have influenced ICT-related experiences in both countries. Finnish schools were closed for 38 to 50 days, while schools in Chile were closed for a total of 259 days (OECD, 2022). The discrepancy underscores the relevance of local conditions shaping experiences with digital technology, and how teacher training and ongoing PD matter for ICT integration. Such initiatives should also be supported by policies that promote high-quality teaching with digital technologies which could be considered far from well-developed in the Chilean context. Supporting ICT uses, PD programs should encompass various elements, including curriculum design, subject matter, teaching methods, and pedagogical theories. These components must align coherently with the practical applications and local conditions. Addressing these areas could help teachers and schools overcome the limitations observed, particularly where global ICT trends need to be more carefully balanced with local decision-making. Further research on how pedagogical innovations can improve the quality of teaching and learning through ICT on a larger scale is also welcome to address current gaps in technology integration.

Finally, more research is required in both contexts to further a 'glocal' approach to ICT integration (Barker et al., 2013; Manca et al., 2021). This approach would help balance current perspectives and support local teachers in their integration efforts. Our study shows that a 'glocal' perspective could significantly contribute to teachers' PD by bridging global trends and more universal learning theories with localized, context-sensitive ICT practices, enhancing the relevance and potential scalability of teachers' ICT use. By investigating technology cross-contextually, we have sought to foster shared learning across borders, highlighting both global patterns and particular context-specific solutions. With more projects like the current one, we believe it could broaden the scope of educational innovation and promote a more equitable and inclusive adoption of educational technology (Manca et al., 2021).

CONCLUSION

This study examined teachers' pedagogical uses of ICT in Chile and Finland through a systematic review using a meta-aggregative analytical approach. By critically evaluating and synthesizing research on ICT adoption in schools from both countries, the study aimed to uncover how global advancements in digital

technology and pedagogies could be adapted to fit local contexts, inspired by a ‘glocal’ framework. This approach emphasizes the importance of combining global knowledge with local needs, which is crucial for addressing the unique challenges different regions face in integrating digital resources into educational systems, including disparities in ICT infrastructure, digital competencies, and pedagogical traditions.

Our findings revealed key patterns and themes regarding educational technology use in both countries. The two syntheses highlight gaps in the current understanding of ICT adoption, particularly in how different approaches to ICT integration are shaped by the research methods used. Moreover, the review showed an overall lack of alignment between globally relevant theory and locally contextualized practices in pre-pandemic studies, which could promote more successful digital learning environments in schools. The synthesis also underscored how teachers’ ICT use and experiences during the pandemic varied due to context-sensitive factors, such as country-specific conditions and available support systems, with different implications for the countries under consideration.

Collectively, the findings from this study offer valuable insights for academic and teaching communities into the current state-of-art knowledge on ICT integration in the two contexts. As portrayed by our study, cross-national comparisons like the present study could serve as case studies for further analysis of educational technology integration, especially concerning striking a critical balance between global and local dimensions in teachers’ pedagogical use of ICT. The adoption of a ‘glocal’ approach provides a more nuanced understanding of the conditions necessary for optimal ICT integration. The insights gained can scaffold potential next steps in research and policy, such as exploring more teacher experiences, developing contextually relevant support systems, or determining trends in local ICT uses. This would enable a better understanding and application of educational technology among teachers.

To substantiate the findings of this study concerning teachers’ ICT use in both countries, further research, including larger sample sizes, is recommended. For broader insights into how the presented findings apply to ICT uses in other contexts, future studies should also aim to apply a ‘glocal’ approach to educational technology research in other settings, expanding current knowledge of optimal ICT integration among teachers in primary and secondary education.

Author contributions: All authors equally contributed to this study. All authors approved the final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Acknowledgments: The authors would like to thank Dr. Álvaro González Torres who read and commented on an earlier version of the paper.

Ethics declaration: This systematic review is based only on data available in online databases. Since no primary data collection or participant interaction was involved, this investigation does not fall within the scope requiring ethical approval. Thus, applicable criteria and guidelines considered it exempt from ethical review.

Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

REFERENCES

- Aromataris, E., & Munn, Z. (2020). JBI systematic reviews. In E. Aromataris, & Z. Munn (Eds.), *JBI Reviewer's Manual* (pp. 14–22). JBI. <https://doi.org/10.46658/JBIMES-20-02>
- Ávalos, B., Flores, M. A., & Aráneda, S. (2022). Battling to keep education going: Chilean and Portuguese teacher experiences in COVID-19 times. *Teachers and Teaching. Theory & Practice*, 28(2), 131–148. <https://doi.org/10.1080/13540602.2021.2012758>
- Aydin, M. (2022). A multilevel modeling approach to investigating factors impacting computer and information literacy: ICILS Korea and Finland sample. *Education and Information Technologies*, 27, 1675–1703. <https://doi.org/10.1007/s10639-021-10690-1>
- Azorín, C., & Fullan, M. (2022). Leading new, deeper forms of collaborative cultures: Questions and pathways. *Journal of Educational Change*, 23, 131–143. <https://doi.org/10.1007/s10833-021-09448-w>
- Barker, K., Omoni, G., Wakasiaka, S., Watiti, J., Mathews, M., & Lavender, T. (2013). Moving with the times taking a glocal approach: A qualitative study of African student nurse views of e learning. *Nurse Education Today*, 33(4), 407–412. <https://doi.org/10.1016/j.nedt.2013.01.001>

- Bond, M., Zawaki-Richter, O., & Nichols, M. (2019). Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology. *British Journal of Educational Technology*, 50(1), 12–63. <https://doi.org/10.1111/bjet.12730>
- Chanpet, P., Chomsuwan, K., & Murphy, E. (2020). Online project-based learning and formative assessment. *Technology, Knowledge and Learning*, 25, 685–705. <https://doi.org/10.1007/s10758-018-9363-2>
- Claro, M., & Jara, I. (2020). The end of Enlaces: 25 years of an ICT education policy in Chile. *Digital Education Review*, 37, 96–108. <https://doi.org/10.1344/der.2020.37.96-108>
- Claro, M., Salinas, A., Cabello-Hut, C., San Martín, E., Preiss, D., Valenzuela, S., & Jara, I. (2018). Teaching in a digital environment (TIDE): Defining and measuring teachers' capacity to develop students' digital information and communication skills. *Computers & Education*, 121, 162–174. <https://doi.org/10.1016/j.compedu.2018.03.001>
- Cook, V., Warwick, P., Vrikki, M., Major, L., & Wegerif, R. (2019). Developing material-dialogic space in geography learning and teaching: Combining a dialogic pedagogy with the use of a microblogging tool. *Thinking Skills and Creativity*, 31, 217–231. <https://doi.org/10.1016/j.tsc.2018.12.005>
- Cortes Abarca, G. (2021). Implementation of emergency remote teaching in Chilean schools due to COVID-19. *Journal of Education and e-Learning Research*, 8(3), 313–323. <https://doi.org/10.20448/journal.509.2021.83.313.323>
- Crompton, H., & Burke, D. (2020). Mobile learning and pedagogical opportunities: A configurative systematic review of PreK-12 research using the SAMR framework. *Computers & Education*, 156, Article 103945. <https://doi.org/10.1016/j.compedu.2020.103945>
- Crook, C., Harrison, C., Farrington-Flint, L., Tomas, C., & Underwood, J. (2010). *The impact of technology: Value added classroom practice*. BECTA. http://webarchive.nationalarchives.gov.uk/20101102103713/http://schools.becta.org.uk/upload-dir/downloads/page_documents/research/reports/the_impact_of_technology.pdf
- Dindar, M., Soursa, A., Hermes, J., Karpinnen, P., & Näykki, P. (2021). Comparing technology acceptance of K-12 teachers with and without prior experience of learning management systems: A COVID-19 pandemic study. *Journal of Computer Assisted Learning*, 37(6), 1553–1565. <https://doi.org/10.1111/jcal.12552>
- Dourish, P. (2017). *The stuff of bits: An essay on the materialities of information*. MIT Press. <https://doi.org/10.7551/mitpress/10999.001.0001>
- EUN. (2017). *Finland country report on ICT in education*. European Schoolnet. <http://www.eun.org/documents/411753/839549/Country+Report+Finland+2017.pdf>
- Farias-Gaytan, S., Aguaded, I., & Ramirez-Montoya, M. S. (2023). Digital transformation and digital literacy in the context of complexity within higher education institutions: A systematic literature review. *Humanities and Social Sciences Communications*, 10, Article 386. <https://doi.org/10.1057/s41599-023-01875-9>
- Finnish Ministry of Education. (2010). Koulutuksen tietoyhteiskuntakehittäminen 2020: Parempaa laatua, tehokkaampaa yhteistyötä ja avoimempaa vuorovaikutusta [Information society development of education 2020: Better quality, more efficient cooperation and more open interaction]. *Finnish Ministry of Education*. <https://julkaisut.valtioneuvosto.fi/handle/10024/75547?show=full>
- Fullan, M., & Langworthy, M. (2014). *A rich seam: How new pedagogies find deep learning*. Pearson. https://michaelfullan.ca/a-rich-seam-how-new-pedagogies-find-deep-learning/3897-rich_seam_web/
- Hämäläinen, R., & Oksanen, K. (2014). Collaborative 3D learning games for future learning: Teachers' instructional practices to enhance shared knowledge construction among students. *Technology, Pedagogy and Education*, 23(1), 81–101. <https://doi.org/10.1080/1475939X.2013.838451>
- Hattie, J. (2023). *Visible learning: The sequel: A synthesis of over 2,100 meta-analyses relating to achievement*. Taylor and Francis. <https://doi.org/10.4324/9781003380542>
- Hinojosa, J. E., Ibieta, A., Claro, M., & Labbé, C. (2016). Characterisation of teachers' use of computers and Internet inside and outside the classroom: The need to focus on the quality. *Education and Information Technologies*, 21, 1595–1610. <https://doi.org/10.1007/s10639-015-9404-6>
- Ibieta, A., Hinojosa, J. E., Labbé, C., & Claro, M. (2017). The role of the Internet in teachers' professional practice: Activities and factors associated with teacher use of ICT inside and outside the classroom. *Technology, Pedagogy and Education*, 26(4), 425–438. <https://doi.org/10.1080/1475939X.2017.1296489>

- Karakainen, M. T., & Saikkonen, L. (2021). Multilevel analysis of the educational use of technology: Quantity and versatility of digital technology usage in Finnish basic education schools. *Journal of Computer Assisted Learning*, 37(4), 953–965. <https://doi.org/10.1111/jcal.12534>
- Kankaanranta, M. (2009). National policies and practices on ICT in Education: Finland. In T. Plomp, R. E. Anderson, N. Law, & A. Quale (Eds.), *Cross-national information and communication technology: Policies and practices in education* (pp. 297–313). Information Age.
- Kennedy, E. T., & Laurillard, D. (2023). *Online learning futures: An evidence-based vision for global professional collaboration on sustainability*. Bloomsbury Academic.
- Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *The Journal of Education*, 193(3), 13–19. <https://doi.org/10.1177/002205741319300303>
- Kozma, R. (2008). Comparative analyses of policies for ICT in education. In J. Voogt, & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 1083–1096). Springer. https://doi.org/10.1007/978-0-387-73315-9_68
- Lager, A., & Lavonen, J. (2023). Engaging students in scientific practices in a remote setting. *Education Sciences*, 13(5), Article 431. <https://doi.org/10.3390/educsci13050431>
- Lakkala, M., & Ilomäki, L. (2015). A case study of developing ICT-supported pedagogy through a collegial practice transfer process. *Computers & Education*, 90, 1–12. <https://doi.org/10.1016/j.compedu.2015.09.001>
- Lankshear, C., & Knobel, M. (2015). Digital literacy and digital literacies: Policy, pedagogy and research considerations for education. *Nordic Journal of Digital Literacy*, 10, 8–20. <https://doi.org/10.18261/ISSN1891-943X-2015-Jubileumsnummer-02>
- Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.
- Laurillard, D., Kennedy, E. T., Charlton, P., Wild, J., & Dimakopoulos, D. (2018). Using technology to develop teachers as designers of TEL: Evaluating the learning designer. *British Journal of Educational Technology*, 49(6), 1044–1058. <https://doi.org/10.1111/bjet.12697>
- Lavonen, J. (2020). Curriculum and teacher education reforms in Finland that support the development of competences for the twenty-first century. In F. M. Reimers (Ed.), *Audacious education purposes: How governments transform the goals of education systems* (p. 65–80). Springer. https://doi.org/10.1007/978-3-030-41882-3_3
- Lindberg, L. (Ed). (2022). European Schoolnet. *European Schoolnet*. <http://www.eun.org/documents/411753/1866395/EUN+Work+Programme+2022+v2.pdf/b6f594ab-94cd-4749-a955-39b3e55810b0>
- Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford Review of Education*, 38(1), 9–24. <https://doi.org/10.1080/03054985.2011.577938>
- Lockwood, C., Porritt, K., Munn, Z., Rittenmeyer, L., Salmond, S., Bjerrum, M., Loveday, H., Carrier, J., & Stannard, D. (2020). Systematic reviews of qualitative evidence. In E. Aromataris, & Z. Munn (Eds.), *JBI reviewer's manual* (pp. 23–71). JBI. <https://doi.org/10.46658/JBIMES-20-03>
- Loukomies, A., & Juuti, K. (2021). Primary students' experiences of remote learning during COVID-19 school closures: A case study of Finland. *Education Sciences*, 11(9), Article 560. <https://doi.org/10.3390/educsci11090560>
- Lowyck, J. (2013). Bridging learning theories and technology-enhanced learning environments. In M. Spector, D. Merrill, M. Ellen, M., & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (pp. 3–20). Springer. https://doi.org/10.1007/978-1-4614-3185-5_1
- Luckin, R. (Ed.). (2018). *Enhancing learning and teaching with technology: What the research says*. UCL Institute of Education Press.
- Manca, S., Bocconi, S., & Gleason, B. (2021). “Think globally, act locally”: A glocal approach to the development of social media literacy. *Computers & Education*, 160, Article 104025. <https://doi.org/10.1016/j.compedu.2020.104025>
- Mankki, V. (2022). Primary teachers' principles for high-quality distance teaching during COVID-19. *Scandinavian Journal of Educational Research*, 66(5), 852–864. <https://doi.org/10.1080/00313831.2021.1939141>
- Mankki, V., & Rähkä, P. (2022). Primary teachers' professional learning during a COVID-19 school lockdown. *Educational Research*, 64(1), 1–17. <https://doi.org/10.1080/00131881.2021.2013127>

- Mateus, J.-C., Andrada, P., González-Cabrera, C., Ugalde, C., & Novominsky, S. (2022). Teachers' perspectives for a critical agenda in media education post COVID-19. A comparative study in Latin America. *Comunicar*, 30(70), 9–19. <https://doi.org/10.3916/C70-2022-01>
- Meisalo, V., Lavonen, J., Sormunen, K., & Vesisenaho, M. (2010). *ICT in Finnish initial teacher education: Country report for the OECD/CERI New Millennium Learners Project ICT in Initial Teacher Training*. Ministry of Education and Culture. <https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/75509/okm25.pdf?sequence=1&isAllowed=y>
- Michos, K., Hernández-Leo, D., & Albó, L. (2018). Teacher-led inquiry in technology-supported school communities. *British Journal of Educational Technology*, 49(6), 1077–1095. <https://doi.org/10.1111/bjet.12696>
- Niemi, H., Kynäslähti, H., & Vahtivuori-Hänninen, S. (2013). Towards ICT in everyday life in Finnish schools: Seeking conditions for good practices. *Learning, Media & Technology*, 38(1), 57–71. <https://doi.org/10.1080/17439884.2011.651473>
- Nussbaum, M., Álvarez, C., McFarlane, A., Gómez, F., Claro, S., & Radovic, D. (2009). Technology as small group face-to-face collaborative scaffolding. *Computers & Education*, 52, 147–153. <https://doi.org/10.1016/j.compedu.2008.07.005>
- OECD. (2009). *Creating effective teaching and learning environments: First results from TALIS*. OECD Publishing. <https://doi.org/10.1787/9789264068780-en>
- OECD. (2022). *Education at a glance 2022: OECD indicators*. OECD Publishing. <https://doi.org/10.1787/3197152b-en>
- Oliver, M. (2013). Learning technology: Theorising the tools we study. *British Journal of Educational Technology*, 44(1), 31–43. <https://doi.org/10.1111/j.1467-8535.2011.01283.x>
- Ottestad, G. (2010). Innovative pedagogical practice with ICT in three Nordic countries – differences and similarities. *Journal of Computer Assisted Learning*, 26(6), 478–491. <https://doi.org/10.1111/j.1365-2729.2010.00376.x>
- Potter, J., & McDougall, J. (2017). *Digital media, culture and education: Theorising third space literacies*. Palgrave MacMillan. <https://doi.org/10.1057/978-1-137-55315-7>
- Prestridge, S. (2017). Examining the shaping of teachers' pedagogical orientation for the use of technology. *Technology, Pedagogy and Education*, 26(4), 367–381. <https://doi.org/10.1080/1475939X.2016.1258369>
- Saadati, F., Giaconi, V., Chandia, E., Fuenzalida, N., & Rodríguez Donoso, M. (2021). Beliefs and practices about remote teaching processes during the pandemic: A study with Chilean mathematics teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(11), Article em2023. <https://doi.org/10.29333/ejmste/11201>
- Salinas, Á., Nussbaum, M., Herrera, O., Solarte, M. & Aldunate, R. (2017). Factors affecting the adoption of information and communication technologies in teaching. *Education and Information Technologies*, 22(5), 2175–2196. <https://doi.org/10.1007/s10639-016-9540-7>
- Sánchez, J., Salinas, A., & Harris, J. (2011). Education with ICT in South Korea and Chile. *International Journal of Educational Development*, 31(2), 126–148. <https://doi.org/10.1016/j.ijedudev.2010.03.003>
- Seitamaa-Hakkarainen, P., Viilo, M., & Hakkarainen, K. (2010). Learning by collaborative designing: Technology-enhanced knowledge practices. *International Journal of Technology and Design Education*, 20, 109–136. <https://doi.org/10.1007/s10798-008-9066-4>
- Selwyn, N. (2022). *Education and technology: Key issues and debates*. Bloomsbury Academic. <https://doi.org/10.5040/9781350145573>
- Selwyn, N. (2023). Digital degrowth: Toward radically sustainable education technology. *Learning, Media & Technology*, 49(2), 186–199. <https://doi.org/10.1080/17439884.2022.2159978>
- Sipilä, K. (2011). No pain, no gain? Teachers implementing ICT in instruction. *Interactive Technology and Smart Education*, 8(1), 39–51. <https://doi.org/10.1108/17415651111125504>
- Sipilä, K. (2014). Educational use of information and communications technology: Teachers' perspective. *Technology, Pedagogy and Education*, 23(2), 225–241. <https://doi.org/10.1080/1475939X.2013.813407>
- Sothayapetch, P., & Lavonen, J. (2022). Technological pedagogical content knowledge of primary school science teachers during the COVID-19 in Thailand and Finland. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(7), Article em2124. <https://doi.org/10.29333/ejmste/12118>

- Tondeur, J., van Braak, J., Ertmer, P., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational Technology Research and Development*, 65(3), 555–575. <https://doi.org/10.1007/s11423-016-9481-2>
- Turvey, K., & Pachler, N. (2018). Tablet devices in education: Beyond face-value. In R. Luckin, R. (Ed.), *Enhancing learning and teaching with technology: What the research says* (pp. 154–164). UCL Institute of Education Press.
- Vääätäjä, J. O., & Ruokamo, H. (2021). Conceptualizing dimensions and a model for digital pedagogy. *Journal of Pacific Rim Psychology*, 15. <https://doi.org/10.1177/1834490921995395>
- Vásquez, A., Nussbaum, M., Strasser, K., Sciarresi, E., Martínez, T., Barahona, C., & Strasser, C. (2017). The impact of the technology used in formative assessment: The case of spelling. *Journal of Educational Computing Research*, 54(8) 1142–1167. <https://doi.org/10.1177/0735633116650971>
- Videla, R., Rossel, S., Muñoz C., & Aguayo, C. (2022). Online mathematics education during the COVID-19 pandemic: Didactic strategies, educational resources, and educational contexts. *Education Sciences*, 12(7), Article 492. <https://doi.org/10.3390/educsci12070492>
- Vivitsou, M., Tirri, K., & Kynäslähti, H. (2016). Science teachers' metaphors of digital technologies and social media in pedagogy in Finland and in Greece. In G. Tsihrintzis, M. Virvou, & L. Jain (Eds.), *Intelligent computing systems: Studies in computational intelligence* (pp. 161–175). Springer. https://doi.org/10.1007/978-3-662-49179-9_7
- Webb, M. (2014). Pedagogy and ICT. In M. Leask, & N. Pachler (Eds.), *Learning to teach with ICT in the secondary school: A companion to school experience* (pp. 67–83). Routledge. <https://doi.org/10.4324/9780203124208-5>
- Weinstein, J., Peña, J., Sembler, M., & Ansoleaga, E. (2022). A time for benevolence. Trust between students and faculty at Chilean public high schools during the COVID-19 crisis. *Teachers and Teaching: Theory and Practice*, 30(7–8), 1043–1055. <https://doi.org/10.1080/13540602.2022.2062738>
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: Digital technologies and distance education during the coronavirus emergency. *Learning, Media and Technology*, 45(2), 107–114. <https://doi.org/10.1080/17439884.2020.1761641>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, 16, Article 39. <https://doi.org/10.1186/s41239-019-0171-0>

APPENDIX A

Table A1. Articles on pedagogical uses of ICT before the pandemic (2013–2020)

Reference	Article's name	Journal/Book	Primary data sources	Respondents
Claro et al. (2018)	Teaching in a digital environment (TIDE): Defining and measuring teachers' capacity to develop students' digital information and communication skills	Computers & Education	Performance-based test and a survey measuring teachers' ICT competencies	828 Chilean school teachers
Hämäläinen and Oksanen (2014)	Collaborative 3D learning games for future learning: Teachers' instructional practices to enhance shared knowledge construction among students	Technology, Pedagogy and Education	Class observations and video recorded group discussions	27 vocational students aged 16 and 18, and 3 teachers
Hinostroza et al. (2016)	Characterisation of teachers' use of computers and Internet inside and outside the classroom: The need to focus on the quality	Education and Information Technology	Semi-structured interviews and class observations	3 teachers working in 4 government subsidized urban Chilean schools
Ibieta et al. (2017)	The role of the Internet in teachers' professional practice: Activities and factors associated with teacher use of ICT inside and outside the classroom	Technology, Pedagogy and Education	Nationwide survey	6,932 Chilean school teachers
Lakkala and Ilomäki (2015)	A case study of developing ICT-supported pedagogy through a collegial practice transfer	Computers & Education	Tutored teachers' self-reported experiences in interviews	2 Finnish school teachers
Niemi et al. (2013)	Towards ICT in everyday life in Finnish schools: Seeking conditions for good practice	Learning, Media & Technology	Participant observations	20 Finnish schools
Nussbaum et al. (2009)	Technology as small group face-to-face collaborative scaffolding	Computers & Education	Design-based research involving four phases (i.e., problem statement, individual response, collective decision, and new proposal)	Intervention in 3 different groups of students within a school community
Ottestad (2010)	Innovative pedagogical practice with ICT in three Nordic countries—Differences and similarities	Journal of Computer Assisted Learning	Analysis of SITES (2006) statistical data	School teachers from 3 Nordic countries: Denmark, Finland, and Norway
Salinas et al. (2017)	Factors affecting the adoption of information and communication technologies in teaching	Education and Information Technology	Online survey	89 teachers
Seitamaa-Hakkarainen et al. (2010)	Learning by collaborative designing: Technology-enhanced knowledge practices.	International Journal of Technology and Design Education	Students' project diaries and Knowledge Forum's Database	31 fourth grade students and their responsible teacher
Sipilä (2014)	Educational use of information and communications technology: Teachers' perspective	Technology, Pedagogy and Education	Survey	292 Finnish school teachers
Vásquez et al. (2017)	The impact of the technology used in formative assessment: The case of spelling	Journal of Educational Computing Research	Design-based research involving interviews and observations throughout two phases: (1) Formative assessment strategy for teaching spelling & (2) Analysis of the impact of different technologies on this strategy	Native Spanish-speaking students in the early years of primary school, in government - subsidized Chilean schools
Vivitsou et al. (2016)	Science teachers' metaphors of digital technologies and social media in pedagogy in Finland and in Greece	Intelligent Computing Systems: Studies in Computational Intelligence [Book]	Semi-structured interviews	1 Finnish school teacher, 3 Greek school teacher, and 2 science education experts

APPENDIX B

Table B1. Articles on pedagogical uses of ICT during the COVID-pandemic (2020–2023)

Reference	Article's name	Journal/Book	Primary data sources	Respondents
Ávalos et al. (2022)	Battling to keep education going: Chilean and Portuguese teacher experiences in COVID-19 times	Teachers and Teaching: Theory and Practice	Online survey	2,205 teachers in Chile and Portugal (all school levels)
Aydin (2022)	A multilevel modelling approach to investigating factors impacting computer and information literacy: ICILS Korea and Finland sample	Education and Information Technologies	International computer and information literacy study and ICILS questionnaires	142 teachers and 2,109 students in the Finnish sample & 147 teachers and 2,616 students in the Korean sample
Cortes Abarca (2021)	Implementation of emergency remote teaching in Chilean schools due to COVID-19	Journal of Education and e-Learning Research	Dynamic online survey	696 teachers from preschool, elementary, and high-school levels, & experts on education
Dindar et al. (2021)	Comparing technology acceptance of K-12 teachers with and without prior experience of learning management systems: A COVID-19 pandemic study	Journal of Computer Assisted Learning	Online survey	196 primary school teachers and subject teachers
Lager and Lavonen (2023)	Engaging students in scientific practices in a remote setting	Education Sciences	Collaborative online physics assignments and interviews	16 upper secondary first-year students
Loukomies and Juuti (2021)	Primary students' experiences of remote learning during COVID-19 school closures: A case study of Finland	Education Sciences	369 instant video blogging	23 Finnish fifth-grade students (aged 11–12 years)
Mankki (2022)	Primary teachers' principles for high-quality distance teaching during COVID-19	Scandinavian Journal of Educational Research	Semi-structured individual interviews	20 Finnish primary school teachers (all grades) from different parts of the country
Mankki and Rähä (2022)	Primary teachers' professional learning during a COVID-19 school lockdown	Educational Research	Semi-structured individual interviews	20 Finnish primary teachers who had delivered distance teaching
Mateus et al. (2016)	Teachers' perspectives for a critical agenda in media education post COVID-19. A comparative study in Latin America	Comunicar	8 online focus group in total grey literature	Primary school teachers of four countries
Saadati et al. (2021)	Beliefs and practices about remote teaching processes during the pandemic: A study with Chilean mathematics teachers	Eurasia Journal of Mathematics, Science and Technology Education	Online surveys	423 in-service mathematics teachers
Sothayapetch and Lavonen (2022)	Technological pedagogical content knowledge of primary school science teachers during the COVID-19 in Thailand and Finland	Eurasia Journal of Mathematics, Science and Technology Education	Semi-structured interviews	12 voluntary primary school teachers from Finland and Thailand, 6 teachers in Helsinki, and 6 teachers in Bangkok
Videla et al. (2022)	Online mathematics education during the COVID-19 pandemic: Didactic strategies, educational resources, and educational contexts	Education Sciences	Online questionnaire	105 primary teachers from urban and rural areas
Weinstein et al. (2022)	A time for benevolence. Trust between students and faculty at Chilean public high schools during the COVID-19 crisis	Teachers and Teaching: Theory and Practice	Online semi-structured interviews (few by phone)	36 students and 36 teachers from 6 high schools

