FACULTY OF EDUCATION
DEPARTMENT OF EDUCATION AND SPECIAL EDUCATION

ICT-INTEGRATED PRACTICES IN FINNISH SCHOOLS:

EXAMINING INSTITUTIONAL AND INDIVIDUAL INFLUENCES – EVIDENCE FROM ICILS 2018

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Abstract

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Aim: This thesis employs a quantitative research approach, utilising data from ICILS 2018 to investigate the influence of ICT usage on teachers' ICT-integrated practices in Finnish schools. The research specifically examines the impact of institutional and individual factors, including leadership support, professional development, teamwork, and teacher attitudes, on these activities. In line with contemporary educational discourse, this study contributes to understanding how systemic and personal conditions shape teachers' integration of ICT into pedagogical practices aimed at enhancing student engagement and learning outcomes.

Theory: The social constructivist perspective provides the foundation for understanding how institutional and individual factors shape teachers' ICT-integrated teaching practices. Building upon Vygotsky's Sociocultural Theory and his notion of mediation, this study conceptualises ICT as a cultural tool that supports socially mediated learning and instructional development. Within this framework, factors such as professional development, leadership support, collaboration among peers, and teacher attitudes are interpreted as culturally and institutionally structured supports that scaffold ICT use in classroom practices. Furthermore, the literature review offers a clear empirical basis by presenting validated relationships between these variables and ICT integration in teaching.

Method: Data analyses were conducted using a regression-based approach, drawing on quantitative data from the ICILS 2018 teacher questionnaire. The analytical procedure involved Pearson correlation, simple regression, and multiple regression analyses, all performed using IBM SPSS. These analyses examined the relationships between institutional factors (leadership support for ICT use, professional development, teacher collaboration) and individual factors (teachers' attitudes towards ICT) on ICT-integrated teaching practices. This approach enabled the identification of both individual and combined effects of these variables on teachers' use of ICT in classroom instruction.

Results: The findings reveal that institutional and individual factors particularly leadership support, professional development, and collaboration positively impact teachers' ICT-integrated practices. These factors were associated with more frequent and meaningful use of ICT to foster student engagement and enhance learning outcomes. While the direct effects were substantial, the results also highlighted that certain institutional constraints, such as inconsistent access to training or limited collaborative structures, may hinder the full potential of ICT integration. These findings underscore the importance of systemic scaffolding through policy alignment, leadership vision, and continuous professional development to support sustainable digital teaching practices in schools.

Foreword

Writing this thesis has been a journey of growth, shaped by challenges and insights. Moments of doubt became opportunities for deeper understanding, making this work a testament to perseverance and intellectual exploration.

This research critically examines how ICT shapes educational methods. Technology's unrelenting advancement is transforming how we live, work, and learn, but it also brings great responsibility. To protect students from exclusion and empower them to thrive in a digital age, education institutions must ensure that no teacher or student is left behind. This thesis examines how institutional support, individual agency, and self-efficacy promote inclusive, ICT-integrated education. This thesis is both an intellectual contribution and a call to action for fair technology integration in education. It shows that with the correct assistance, perspective, and collective resolve, we can handle digital transition in inclusive, empowering, and forward-looking ways.

The completion of this work would not have been possible without the unwavering support and encouragement I have received along the way. I am deeply grateful to my supervisor, Aimee Haley, whose patience, insightful guidance, and steadfast positivity provided both academic direction and personal reassurance throughout this process. Her constructive feedback and belief in my capabilities have been invaluable. To my family and friends both those who have supported me from afar and those I have been fortunate to meet during my time in Gothenburg I extend my heartfelt thanks. Your encouragement, understanding, and timely words of motivation, especially in the final, most demanding stages, have been a cornerstone of this achievement. I also wish to acknowledge the Swedish Institute for its generous scholarship support, which made this academic pursuit possible. It stands as a testament to the power of opportunity and the importance of investing in education as a force for social progress.

"Go alone if you want to move quickly. Go together if you want to go far."
This African saying serves as a reminder that even the most ambitious journeys are attainable with teamwork, encouragement, and a common goal.

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UNIVERSITY OF GOTHENBURG

DEPARTMENT OF EDUCATION AND SPECIAL EDUCATION

Introduction

The integration of Information and Communication Technologies (ICT) into classroom instruction represents a crucial element of modern educational reform, particularly in countries with advanced digital infrastructures such as Finland. While significant investments have been made globally to integrate digital tools within educational systems including improved access to broadband, mobile devices, and virtual learning environments the mere existence of ICT does not automatically translate into effective pedagogical application (OECD, 2015; Biagi & Loi, 2019). Finland, often praised for its exemplary education system and digital competency measures, illustrates this dichotomy. Despite being classified among the most digitally equipped education systems in Europe (European Schoolnet & University of Liège, 2012), both national and cross-national data indicate that ICT is still used unevenly by teachers, with considerable variation in how, when, and why technology integration is applied in classrooms (Fraillon et al., 2020; Kaarakainen & Saikkonen, 2021). Understanding the factors that facilitate efficient ICT integration is therefore a primary priority for scholars and policymakers alike.

The 2018 cycle of the International Computer and Information Literacy Study (ICILS 2018) presents a robust opportunity to explore these dynamics. With its focus on both structural conditions and individual teacher attributes, ICILS 2018 offers rich empirical data that enable a systematic examination of the interplay between institutional enablers, teacher attitudes, and ICT use. Particularly in the Finnish context where educational decentralisation coincides with ambitious digitalisation objectives it is essential to evaluate whether teachers are receiving sufficient support and whether they possess the necessary attitudes and competencies to utilise ICT in ways that enhance student learning and engagement.

This thesis therefore aims to examine the degree to which institutional and individual factors influence teachers' ICT-integrated teaching practices in Finnish schools. The analysis is grounded in Vygotsky's Sociocultural Theory (1978), which conceptualises learning and development as socially mediated processes. Within this framework, ICT is regarded not merely as a technical asset, but as a cultural artefact a mediating tool that acquires pedagogical meaning through interaction with social environments such as peer collaboration, leadership structures, and professional learning communities. Furthermore, the concept of the Zone of Proximal Development (ZPD) is used to understand how

teachers move from reliance on external support to independent utilisation of ICT in instruction, aided by scaffolding strategies such as professional development and collaborative networks.

The thesis investigates the direct relationships between institutional and individual factors and ICT-integrated teaching practices using nationally representative ICILS 2018 teacher data from Finland. Specifically, the study tests how teachers' participation in ICT-related professional development, collaboration in ICT use, leadership support, and attitudes toward ICT predict the frequency and quality of ICT-integrated teaching. These relationships are analysed using Pearson correlation and regression techniques to evaluate both individual and combined effects on classroom ICT practices.
This research is situated within the broader policy context of international and national efforts to promote inclusive and digitally competent education systems. It supports Sustainable Development Goal 4 (Quality Education) and Goal 9 (Industry, Innovation, and Infrastructure), which emphasise the need for equitable digital access and effective use of technology in teaching. The study reinforces the importance of teacher collaboration, positive attitudes toward ICT, and professional development in enabling meaningful and pedagogically grounded ICT integration.

Statement of relevance

The rapid integration of ICT in education has become a focal point of academic and policy discourse, particularly in digitally advanced contexts such as Finland. While research has predominantly emphasised ICT's role in enhancing teaching and learning outcomes, less attention has been given to the institutional and individual factors that shape impactful ICT use in classrooms (Fraillon et al., 2019b). Despite Finland's strong ICT infrastructure, studies reveal variability in teachers' ICT-integrated practices, often influenced by professional development, leadership support, and personal attitudes towards technology (European Schoolnet & University of Liège, 2012). These dynamics highlight that access alone is insufficient; effective ICT use depends on continuous professional development, institutional scaffolding, and the cultivation of positive pedagogical beliefs toward digital technologies (OECD, 2021).
In this context, it is essential to examine how institutional and individual factors interact to foster meaningful ICT integration in classrooms. Finnish students spend considerable time in technology-enriched learning environments, making it crucial to understand how school leadership, collaborative practices, and professional learning communities contribute to pedagogical innovation. This research seeks to provide insights into how ICT can be utilised not only to enhance student engagement and learning but also to strengthen collaborative teaching practices and address potential challenges associated with digitalisation. The outcomes will offer valuable guidance for policymakers and educators in promoting sustainable, socially mediated ICT use, while identifying risks linked to insufficient institutional support or fragmented implementation strategies.

Research aim

The aim of this study is to investigate the impact of institutional and individual factors on teachers' ICT-integrated practices in Finnish schools. Specifically, this research explores how leadership support, professional development, peer collaboration, and teachers' attitudes towards ICT shape the effective integration of ICT in teaching. Both the frequency and pedagogical purpose of ICT use within educational contexts are examined, recognising that its impact is influenced by variables such as initial

digital competence, context of use, and school-level support structures (Jackson, Von Eye, Witt, Zhao, & Fitzgerald, 2011).

Debate regarding the impactfulness of ICT in education intensified following the OECD's (2015) report *Making the Connection*, which argued that substantial investments in ICT had not yielded notable improvements in student outcomes and failed to address educational inequalities. This conclusion prompted widespread scholarly critique. In response, Hu (2017), in *Students, Computers and Learning: Where is the Connection?* presented evidence-based examples showing that ICT, when strategically and pedagogically integrated, enhances teaching quality and learning environments. The study concluded that ICT has transformed educational delivery, expanded learning spaces, and supported more personalised and engaging instructional strategies.

Given that ICT's effects are shaped by evolving institutional conditions and educator practices, definitive claims about its universal impact remain challenging. Nevertheless, this research seeks to illuminate how structured institutional support and teacher-level dispositions collectively influence classroom-level ICT integration. By framing ICT as a cultural artefact that is, a socially and pedagogically situated tool this study emphasises its potential to foster collaboration, innovation, and professional learning within contemporary Finnish classrooms.

Research Questions and Hypotheses

This research adopts a quantitative analytical approach, leveraging data from the ICILS 2018 to examine how institutional and individual factors influence the ICT-integrated teaching practices of teachers in Finland. Specifically, the study investigates how ICT-related professional development, collaboration in ICT use for lesson planning, leadership support for ICT integration, and teachers' attitudes towards ICT use contribute to effective and sustained ICT-enhanced instruction.The research objectives will be achieved by addressing the following research questions (RQs):

1. What is the correlation between institutional and individual factors and ICT-integrated teaching practices of teachers in Finnish schools?
2. How do institutional and individual factors individually predict the ICT-integrated teaching practices of teachers in Finnish schools?
3. How do institutional and individual factors collectively impact the ICT-integrated teaching practices of teachers in Finnish schools?

Building upon findings from the literature, this thesis investigates how institutional and individual factors influence ICT-integrated teaching practices in Finnish schools. To systematically examine these research questions, the study tests the following null hypotheses (H_0) corresponding to each question (Fraillon et al., 2020):

Null Hypotheses

To systematically examine these research questions, the study will test the following null hypotheses (H_0):

1. H_{01}**:** There is no statistically significant correlation between institutional and individual factors and ICT-integrated teaching practices of teachers in Finnish schools.
2. H_{02}**:** Institutional and individual factors do not individually predict ICT-integrated teaching practices of teachers in Finnish schools.
3. H_{03}**:** Institutional and individual factors do not collectively influence ICT-integrated teaching practices of teachers in Finnish schools.

The chapters that follow are organised to systematically address the research objectives. Chapter 2 offers contextual background on ICT integration in Finnish education, situating the study within broader policy and pedagogical developments. Chapter 3 presents a critical review of existing literature, identifying

empirical trends and theoretical gaps related to ICT use and institutional and individual support systems, alongside clearly formulated research questions and hypotheses. Chapter 4 outlines the theoretical and conceptual framework, drawing upon Vygotsky's Sociocultural Theory to conceptualise ICT as a cultural artefact within socially mediated teaching environments. Chapter 5 details the methodology, including the research design, variables, sampling procedures, and ethical considerations pertinent to the use of large-scale secondary data from ICILS 2018. Chapter 6 presents the results of the data analysis using Pearson correlation, simple regression, and multiple regression to test direct relationships between key variables. This is followed by an in-depth discussion of findings in relation to the literature and theoretical framework. The final chapter concludes the thesis with reflections on its contributions to the field, a discussion of its limitations, and concrete recommendations for future research and policy particularly regarding the promotion of digital equity and teacher development within the context of Education for Sustainable Development (ESD).

Limitations

In this study, not all elements of the proposed theoretical framework could be fully operationalised due to limitations within the ICILS 2018 dataset. Certain variables reflecting institutional and individual influences on ICT-integrated teaching practices in Finland were either absent or only broadly represented. For example, while leadership support and teacher collaboration were included, other nuanced aspects of institutional culture such as informal mentoring, dynamic resource allocation, or school-wide ICT strategies were not captured. Additionally, some constructs, such as ICT-integrated teaching practices, relied on composite indicators that may have introduced measurement error or limited the depth of construct specificity.

The study also utilised plausible values provided by ICILS 2018 for achievement-related constructs. Although five plausible values were available, only one was used per construct to simplify analysis. Given that differences between plausible values are typically minimal, this decision is unlikely to have significantly impacted the associations between ICT use and teaching practices. Furthermore, ICILS 2018 does not offer detailed data on subject-specific ICT use, instead focusing on generalised teaching practices. This limited the study's ability to analyse how ICT is used across different disciplines or grade levels.

In addition, while this thesis examined both institutional and individual factors, one of the individual factors teachers' attitudes toward ICT showed only a weak predictive effect. This suggests that favourable attitudes alone may not lead to substantial changes in practice without stronger institutional support or structural enablers. Although further elaboration is presented in the discussion, this underperformance signals a limitation in assuming attitudinal factors can independently predict ICT integration outcomes.

Lastly, as a cross-sectional survey, ICILS 2018 does not permit causal interpretations. The findings are therefore limited to statistical associations, and the scope of generalisability is constrained by the structure and breadth of the dataset.

Ethics

Research ethics are essential for evaluating the quality and impartiality of academic research and for assuring the responsible and beneficial application of results for society at large (Finnish National Board on Research Integrity, 2019). The ICILS (2018), managed by the IEA, exemplifies these standards by

following rigorous ethical protocols that protect participants' rights and ensure data integrity. Participating nations, including Finland, were permitted to modify specific survey components to conform to their national educational systems, as long as they adhered to the overarching international framework. Additionally, each nation designated a National Research Coordinator tasked with supervising the ethical execution of the study, encompassing the secure handling of all confidential data and materials during the assessment process. In Finland, supplementary national data protection procedures were implemented before the dissemination of the public-use dataset (IEA, 2020).

This thesis utilises secondary data from ICILS 2018, strictly adhering to the ethical guidelines guiding such research. Although secondary data analysis generally does not require an extensive ethical assessment, it must nonetheless adhere to many critical requirements (Fraillon et al., 2020). Initially, the original ownership of the data must be expressly recognised. The data utilised in this study are publicly accessible through the IEA's online repository and have been completely anonymised to safeguard participant confidentiality. Secondly, formal approval for data utilisation must be secured. Access was given upon the PDF digital acceptance of the IEA's terms and conditions specified in its Disclaimer and License Agreement. Moreover, it is crucial that the data interpretation adheres to its original design and purpose. This thesis maintains the original content and structure of the ICILS 2018 dataset, with questionnaire questions quoted verbatim and the original survey instruments reprinted in Appendix 1 to ensure transparency and authenticity to the source material.

Clearly, informed consent was obtained from all participants prior to data collection, in line with national ethical standards and international best practices for educational research. As the ICILS 2018 data was not originally collected to address the specific research questions of this thesis, it was imperative to interpret the data in a manner that respects its original context and structure (Fraillon et al., 2020). Throughout this study, all variables have been adopted, utilised, and analysed in accordance with the original intentions of the data provider, IEA. This includes preserving the content of survey items and incorporating direct quotations from the questionnaires to ensure authenticity to the source.

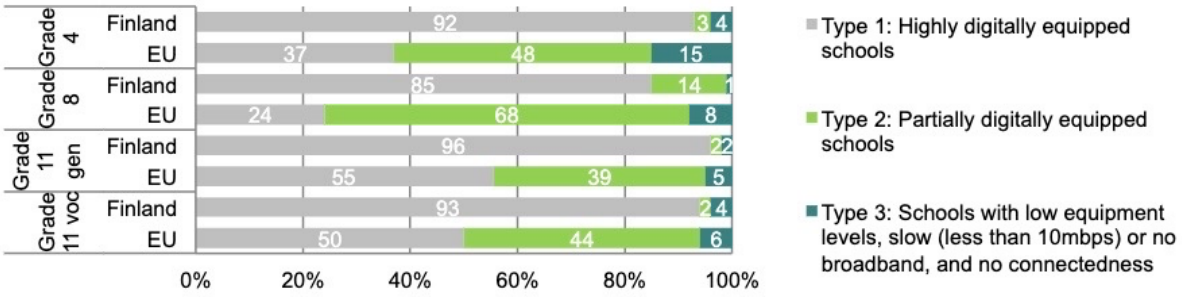
Background

The chapter provides an elaboration of the research problem and its significance, as supported by pertinent literature. The study objective is articulated, concluding the chapter with a discussion of its limitations.

Research problem

Globally, the integration of information and communications technologies (ICT) in education has expanded rapidly, with over 90% of teachers in OECD countries reporting access to digital tools in their schools (OECD, 2019b). Despite this widespread availability, only 53% of teachers feel well-prepared to use ICT effectively in their teaching practices (OECD, 2021). Furthermore, disparities persist, as less than 40% of teachers incorporate ICT into their daily teaching activities (European Commission, 2019). In Finland, a country recognised for its substantial investment in digital infrastructure and educational excellence, ICT resources such as desktop computers, laptops and mobile devices are widely available across schools. Figure 1, shows how Finland compares against other countries at secondary level on this measure, ranking first in the leading group of countries. Moreover, Finnish schools are among the most digitally equipped in Europe, benefiting from extensive broadband connectivity and virtual learning environments (European Schoolnet & University of Liège, 2012; OECD, 2023). Yet, despite this technological advancement, Finnish teachers, like educators worldwide, are increasingly required to engage with digital devices and integrate ICT into their professional practices, yet the extent and impact of this engagement remains inconsistent (OECD, 2014). However, the frequency and pedagogical integration of ICT in classrooms remains limited, particularly at lower secondary levels where teacher utilisation of ICT often falls below the European average (European Schoolnet & University of Liège, 2012). This highlights a critical concern: while access to ICT is prevalent, its effective use to enhance teaching practices and improve student outcomes continues to pose significant challenges.

Figure 1 *Digitally equipped schools (in % students, Finland and EU, 2011-12: European Schoolnet & University of Liège, 2012)*



However, while ICT devices are becoming more prevalent in both classrooms and society, education is still exploring the various ways these technologies can effectively support teaching and learning. Research in this area has produced mixed outcomes. Several studies have found that the integration of technology in education has minimal impact on improving learning outcomes (Fried, 2008; OECD, 2019a). Conversely, other studies highlight the potential benefits of ICT in enhancing educational practices and student engagement (Rodríguez-Triana et al., 2020; Román Carrasco & Murillo Torrecilla, 2012). This suggests a complex and multifaceted relationship between ICT use and educational impact, leaving many aspects unresolved. In response, this study focuses on understanding how institutional factors and individual teacher factors impact ICT-integrated teaching practices in Finnish schools. Drawing on data from the ICILS (2018).

Literature Review

Introduction

In order to provide clear definitions and scope, a thorough literature overview of key constructs is necessary. This study builds upon existing scholarship, particularly in the field of ICT in education, by examining the factors influencing ICT-integrated teaching practices in schools. A comprehensive literature review was conducted, focusing on studies that explore mechanisms contributing to the inclusion and exclusion of ICT practices in educational contexts. The subsections covered in the literature review include: previous studies on ICT utilisation in education, theoretical perspectives on ICT use in teaching and learning, institutional and individual factors impacting ICT-integrated teaching practices, and barriers and considerations in ICT use, culminating in an exploration of the research gap.

As guided by literature review procedures suggested by Randolph (2009), who built on earlier works of Cooper (1986), the literature review adopts an 'integrative review' approach which compiles research studies to provide a holistic understanding of the subject area. The researcher reviewed 30 publications, including peer-reviewed journal articles, academic books, and commissioned reports by professional researchers, predominantly accessed through the University of Gothenburg Library and Google Scholar, as they provided reliable access to all articles, reports, and studies related to the thesis topic.

As a result of using the integrative review, the literature review is structured to progress from a general overview of ICT in education to a detailed examination of how institutional and individual factors impact ICT-integrated teaching practices. The review integrates findings from diverse studies to identify patterns, consistencies, and gaps in existing literature. As such, the literature review covers studies from both developed and developing countries, utilising various research designs, methodologies, and theoretical frameworks (Fraillon et al., 2019a; OECD, 2019b; Ilomäki et al., 2014).

Previous studies were reviewed irrespective of the organisation of ICT integration within different educational systems that is, whether ICT use was implemented as part of a national strategy or through localised school initiatives. To start with, the integration of ICT varies significantly from one country to another, influenced by national policies, institutional strategies, and cultural contexts (Eickelmann & Vennemann, 2017). Most of the studies reviewed concentrated on the 'individual teacher perspective', generating insights into the factors that contribute to both the inclusion and exclusion of ICT practices in educational settings. For instance, studies by Kaarakainen, Saikkonen, and Savela (2019), Schmitz et al. (2023), and Lytras, Patricia, and Aldosemani (2024) highlight how professional development and teacher attitudes impact ICT adoption. Additionally, Ertmer et al. (2012) emphasises the critical role of teacher beliefs in shaping integration outcomes.

A smaller number of studies focus on the role of learning institutions and systemic factors in promoting ICT use. Research by Kaarakainen, Kivinen, and Vainio (2017) emphasises how school leadership and institutional policies create environments that either facilitate or hinder digital integration in classrooms. Only a few studies, such as Kaarakainen, Kaarakainen, and Kivinen (2018), specifically applied a systems theory approach, examining ICT integration within the broader educational system as a dynamic and interdependent process. Additionally, Carbonaro and Breen (2021) argue that effective leadership

is essential for overcoming institutional ICT challenges, reinforcing the need to view ICT implementation not merely as a technical enhancement, but as an organisational transformation process.

Based on the literature reviewed, it is evident that there is a predominant focus on individual factors, such as teacher attitudes and digital competencies, with considerably fewer studies evaluating how inclusive and supportive institutional frameworks impact the promotion of sustained ICT use by teachers. This study seeks to fill this gap by exploring not only the individual factors influencing ICT use but also the institutional conditions that enable or constrain ICT practices in Finnish schools.

ICT in Education

Over the last decade, a study conducted across European classrooms revealed that between 2006 and 2011, the number of computers per student had doubled. The study further highlighted that laptops became widely available and nearly all schools had gained broadband access, significantly enhancing digital learning environments (European Schoolnet & University of Liège, 2012). Similarly, Fraillon et al. (2020) emphasised that embedding digital competence into national curricula, as observed in Finland, is aligned with broader European trends and is essential for equipping students with future-ready skills. The ICILS 2018 report further underlines that in Finland, digital competence is regarded not merely as a supplementary advantage but as a foundational component of effective teaching, with an emphasis on responsible and critical use of digital technologies (Fraillon et al., 2020).

Kaarakainen et al. (2018) support this view, demonstrating that Finnish schools have evolved from emphasising basic digital literacy to fostering advanced digital competencies that integrate pedagogical strategies. Their findings show that schools with coherent digital strategies not only increased teacher engagement with ICT tools but also enhanced instructional quality and student learning outcomes. Expanding on this, Schmitz et al. (2023) argued that fostering digital competence involves more than ensuring access to technology, stressing the role of transformational leadership in promoting ICT use, building teacher agency, and cultivating critical thinking and problem-solving skills. This perspective is echoed by Drossel, Eickelmann, and Gerick (2017), who highlight that leadership, school-level strategies, and teacher collaboration are pivotal in determining meaningful ICT adoption, particularly within European education systems.

The Use of ICT in Teaching and Learning

The use of ICT in education is a multifaceted topic influenced by policy, curriculum, teaching practices, and institutional resources (Eickelmann & Vennemann, 2017; OECD, 2019a). A study conducted by Mikheeva and Meyer (2020), drawing on the International Computer and Information Literacy Study (ICILS) 2018, assessed ICT use in education by focusing on Finland's performance in terms of access and effective use of digital tools in teaching. The study included a diverse sample of teachers and students across Finnish schools, examining both digital competence and teaching effectiveness. The findings revealed that Finnish students and teachers demonstrated high levels of digital competence and confidence, which positively correlated with teaching effectiveness (Fraillon et al., 2019b; Mikheeva & Meyer, 2020).

Similarly, research by Skryabin et al. (2015) highlighted that effective ICT use in school-related tasks has a positive impact on academic performance, especially when such use is strategically integrated into pedagogical practices. This aligns with findings by Comi et al. (2017), who demonstrated that the effectiveness of ICT is not simply dependent on access, but rather on how purposefully and meaningfully

it is embedded within teaching methodologies. In contrast, Biagi and Loi (2013) found that even in European contexts with high ICT infrastructure, the mere availability of digital tools did not necessarily lead to improved educational outcomes. Their study revealed that schools lacking structured digital strategies and sustained teacher development often experienced underutilisation of ICT, reinforcing that strategic alignment with curriculum objectives and consistent institutional support are crucial. These insights mirror arguments by Ertmer et al. (2012), who assert that beyond external access and training, internal teacher beliefs and institutional culture critically shape technology integration practices.

Further expanding on this, Kaarakainen et al. (2018) conducted a longitudinal study in Finnish schools, focusing on the role of professional development and structured ICT strategies in enhancing teachers' digital competencies. The study, which employed surveys and classroom observations, found that schools with robust digital strategies and continuous training programmes demonstrated significant improvements in teachers' capacity to integrate digital tools effectively into pedagogical practices. Importantly, the researchers concluded that providing digital resources alone is insufficient. Instead, sustained professional development and strategic institutional support are necessary to help teachers align ICT use with curriculum goals and pedagogical intentions. These findings are consistent with earlier assertions by Ertmer and Ottenbreit-Leftwich (2010), who emphasised that transformation in teaching practices hinges on both external supports and internal belief systems, including teachers' confidence and instructional values.

Overall, I observed that, while studies generally support the positive impact of ICT-integrated teaching practices, the effectiveness of digital integration depends on the broader educational environment. Schools that combine digital tools with strong leadership, policy support, and teacher training are more likely to maximize the potential of ICT in enhancing student learning outcomes. However, as noted by Biagi and Loi (2013), without these critical elements, the impact of ICT on education may remain limited, highlighting the need for a balanced and strategic approach to digital integration in schools.

Institutional Factors

The adoption of ICT in education is deeply influenced by institutional factors, including leadership commitment, technical support, and structured digital policies (Eickelmann & Vennemann, 2017; Drossel et al., 2017). In the Finnish context, Ilomäki et al. (2014) emphasise that schools with broad institutional frameworks and collaborative cultures are more likely to integrate technology effectively into teaching practices, aligning leadership commitment with daily pedagogical goals. In line with this, Tondeur et al. (2018) found that nations with clear and organized ICT policies generally experience greater ICT-integrated teaching practices in educational settings, as these policies provide a solid framework for resource distribution and pedagogical consistency.

Similarly, Anderson and Dexter (2005), in their research involving school leaders across various educational contexts, noted that school leadership plays a crucial role in promoting a culture of digital learning. The study revealed that principals and administrators who offer explicit guidance, structured support, and continuous professional development opportunities positively influence teachers' willingness to adopt and utilize ICT technologies.

The availability of technical infrastructure and financial investment also emerged as critical factors in a study by Tondeur et al. (2018), which found that schools with allocated budgets for digital resources, professional training, and on-site IT support exhibited higher ICT adoption rates among teachers. Conversely, the study highlighted that even well-designed ICT strategies could fall short if not supported

by adequate infrastructure and funding. Research by Comi et al. (2017) underscores this by showing that schools with financial constraints often struggle to maintain sustainable ICT practices. In the Finnish context, Ilomäki et al. (2014) found that schools with robust institutional support, including access to technology and training opportunities, showed more consistent and effective ICT adoption, contributing positively to digital readiness among teachers.

Leadership and Institutional Policies

A study by Anderson and Dexter (2005), informed by the role of digital leadership in education, examined how institutional policies influence ICT adoption in schools. The study specifically focused on school leadership and its ability to foster an ICT-driven culture among teachers. Findings revealed that effective school leadership extends beyond decision-making and resource distribution; it also requires cultivating an adaptive and innovative environment that encourages teachers to explore digital tools in meaningful ways. Similarly, Carbonaro and Breen (2021) argue that institutional leaders who promote inclusive and forward-thinking organisational cultures empower teachers to embrace ICT and navigate digital transformation with greater confidence. However, variations in leadership commitment across schools result in disparities in ICT implementation, emphasising the need for cohesive national policies to ensure equitable access to digital resources for both students and teachers (Ilomäki et al., 2014).

Institutional policies serve as a foundational pillar in ICT adoption, setting strategic direction for infrastructure development, teacher training, and curriculum integration. Research by OECD (2019a) and Albion et al. (2015) suggests that schools with clearly defined ICT strategies incorporating policy goals, dedicated training programmes, and ongoing technical support demonstrate significantly higher levels of effective technology integration. This resonates with findings by Drossel et al. (2017), who emphasise that collaborative school cultures, underpinned by proactive leadership, are critical to practical ICT implementation.

Beyond internal school policies, external support and partnerships also shape ICT adoption in education. Comi et al. (2017) highlight the importance of systemic support and sustained investment in influencing teacher practices. In Finland, teacher-led innovation in ICT integration has been strongly reinforced through government-funded professional development initiatives and incentives for digital upskilling (Mikheeva & Meyer, 2020). Moreover, collaboration with private technology providers has allowed schools to pilot advanced digital tools and educational innovations (Fraillon et al., 2020). Establishing robust institutional support systems integrating policy alignment, strategic resourcing, and leadership-driven capacity-building is therefore essential to ensuring that ICT adoption becomes a sustainable and transformative force in education rather than a fragmented or short-term initiative.

ICT Infrastructure and Institutional Support

A study by Kaarakainen, Kivinen, and Vainio (2017) examined digital readiness in Finnish schools, with a focus on disparities between urban and rural institutions. Using performance-based ICT skills data, their findings revealed that while Finland exhibits high levels of digital competence, unequal access to ICT resources persists, particularly in rural areas. Similarly, Fraillon et al. (2019b) found that teacher ICT self-efficacy plays a crucial role in determining how effectively digital tools are integrated into classroom instruction. The study indicated that inadequate access to digital resources negatively impacts teachers' confidence and readiness to incorporate ICT into pedagogical practices.

Supporting this argument, Kaarakainen, Saikkonen, and Savela (2019) found that over 35% of teachers in rural Finnish schools reported insufficient access to ICT resources, which hindered their ability to engage in technology-enhanced teaching methodologies. The study highlighted that such infrastructural

deficiencies contribute to a widening digital divide, making it difficult for teachers in under-resourced schools to stay on par with their counterparts in better-equipped institutions. Furthermore, the research suggested that limited ICT infrastructure and lack of continuous training exacerbate disparities in digital competence, thereby reinforcing systemic inequalities in education.

Addressing these challenges requires a comprehensive approach recognizing this Saikkonen and Kaarakainen (2021) emphasize that systematic interventions must be implemented to bridge the digital readiness gap, including increased investment in digital infrastructure and expanded professional development opportunities for teachers. The study further asserts that ensuring equitable access to ICT training programs can help mitigate disparities in technology adoption, allowing teachers across all educational settings to integrate digital tools more effectively into their instruction. Complementing this, Skryabin et al. (2015) highlight that targeted resource allocation and supportive school environments are essential to maximising the educational benefits of ICT.

Ultimately, overcoming these challenges is critical to fostering a more inclusive and technologically empowered education system in Finland. Moreover, Professional Learning Communities (PLCs) have emerged as a cornerstone in the professional development of teachers, particularly in the context of ICT adoption and digital pedagogy. Broadly recognized as collaborative in-school frameworks, PLCs foster ongoing teacher engagement, shared pedagogical values, and structured professional development focused on digital integration (Muukkonen et al., 2019; Wenger, 1998, 2011). Contemporary research on digital technology and practices for school improvement, such as studies by Ilomäki et al. (2014) and Hämäläinen and Cincinnato (2015), emphasizes the pivotal role of PLCs in facilitating ICT adoption, offering structured opportunities for teachers to enhance digital literacy skills and instructional strategies.

In Finland, PLCs serve as a key mechanism for advancing ICT adoption among in-service mathematics and science teachers. Unlike conventional professional development models, PLCs prioritize continuous pedagogical reflection, technology-driven instructional experimentation, and collaborative learning to strengthen teachers' digital competencies (Ilomäki et al., 2014; Fraillon et al., 2019b; Zimmerman, 2022). A significant advantage of PLCs is their ability to cultivate a collective commitment to integrating ICT into education, which has been linked to improved student learning outcomes, particularly in STEM subjects (Kaarakainen et al., 2019). This aligns with findings by Borko et al. (2008), who argue that complex problems in technology adoption require adaptive learning communities that support both content knowledge and professional growth. Acknowledging their importance, Finnish national education policies have reinforced PLCs as a central component of digital education reforms, promoting school-based learning environments where educators collaboratively explore innovative ICT methodologies (Monteiro et al., 2023, as cited in Rodríguez-Triana et al., 2020). Rodríguez-Triana et al. (2020) affirm that PLCs are instrumental in equipping teachers with essential digital skills and strategies to navigate evolving technological landscapes.

By 2023, over 90% of Finnish schools had integrated PLC-driven professional development programs, concentrating on ICT training, digital content creation, and interdisciplinary collaboration among mathematics and science educators (Ilomäki et al., 2014). The impact of PLCs is evident in heightened teacher confidence, structured ICT integration within lesson planning, and enriched student engagement through interactive digital learning experiences (Fraillon et al., 2019b; Kaarakainen et al., 2019). Furthermore, research highlights that embedding technical support within PLCs enhances ICT adoption rates by up to 60% (Tondeur et al., 2018). According to Niemi et al. (2016), access to ICT infrastructure alone does not guarantee sustained adoption. They add that effective integration necessitates a comprehensive approach that combines access to ICT, sustained training, and collaborative peer

engagement. Echoing this, Elstad (2023) and Wilson et al. (2015) reinforce the importance of empowering teachers through ongoing capacity-building efforts blended in school cultures, ensuring that systemic structures support long-term educational transformation.

As a Finnish educator remarked, “Having digital tools in the classroom does not equate to knowing how to use them effectively. Without structured support and collaboration, many of us are left experimenting on our own” (De Wever et al., 2015, p. 47). Findings from the International Computer and Information Literacy Study (ICILS) 2018 further indicate that PLCs act as a crucial mediating factor between institutional ICT policies and individual teacher adoption behaviours (Fraillon et al., 2019b). However, more research is necessary to assess variations in PLC implementation across different educational settings and to determine best practices for optimising their effectiveness in digital learning environments (adapted from Rodríguez-Triana et al., 2020). As Wenger (2011) outlines in his foundational work on communities of practice, sustained collaboration and shared learning goals are central to professional growth and innovation. This is echoed in Wenger’s earlier work, which defines communities of practice as social learning systems shaped by engagement, shared repertoire, and mutual accountability (Wenger, 1998). On the other hand, Hämäläinen and Cincinnato (2015) argue that, while Finnish PLCs align closely with national digital education objectives, ongoing efforts are required to ensure equitable access to ICT training, encourage pedagogical innovation, and support sustainable technology-driven teaching practices in mathematics and science education. Additionally, Zimmerman (2022) highlights the importance of dynamic, context-responsive PLC models in adapting to evolving technological and instructional demands, particularly within hybrid and virtual teaching environments. The following table summarises PLC operations in the Finnish educational landscape, focusing on ICT adoption by mathematics and science in-service teachers. (see *Figure 2*)

Figure 2 The summary of PLC operations within Finnish Schools *(National Agency for Education, Finland, 2023).*

Summary of PLC Operations in Finnish Schools

No.	Key Features of PLC Operations in Finnish Schools
1	School principals support PLC operations with national policy backing.
2	Mathematics and science teachers regularly participate in PLCs.
3	PLCs encourage participation from educators across subjects.
4	Lesson co-design, peer observations, and discussions on ICT pedagogy are prioritized.
5	Coordinators ensure PLCs align with national ICT education strategies.
6	School leaders act as facilitators in PLC digital transformation.
7	External ICT experts provide training and innovative digital tools.
8	Active PLC participants receive professional development credits.
9	Schools allocate funds for ICT resources, training, and materials.
10	PLCs require structured ICT skill development hours for teachers.
11	Lesson sharing, digital resource exchange, and reflective discussions are standard practices.

Individual Factors

Eickelmann and Vennemann, (2017) revealed that at the individual level, teachers' attitudes towards ICT use and age-related digital marginalization, prior experience, and engagement with digital tools also significantly affect their confidence and competence in ICT use. As elaborated below:

Attitudes Toward ICT Use and Age-Related Digital Marginalization

Kaarakainen and Saikkonen (2021) conducted a study investigating the impact of generational differences on ICT adoption in education, with a particular focus on self-efficacy and digital marginalisation. Their research revealed that while younger teachers often exhibit higher enthusiasm for ICT, effective digital integration is not solely dependent on age but rather on exposure, institutional support, and structured professional development. Drossel et al. (2017), using ICILS 2018 data, similarly found that older teachers generally used ICT less frequently in instructional settings. These findings highlight that a deficit in structured support can hinder the effectiveness of even digitally equipped classrooms. As Uusiautti (2012) argues, training effective teachers in Finnish schools requires not only access to digital tools but also sustained pedagogical mentoring and institutional scaffolding throughout the teacher education process.

Moreover, Saikkonen and Kaarakainen (2021) caution against binary classifications of 'young' and 'old' ICT users, noting that such divisions reinforce digital inequality by masking systemic disparities in resource allocation and training. Ertl et al. (2020) emphasise the importance of inclusive professional development initiatives that ensure all educators, regardless of age, have equitable access to digital training. This reflects Wenger's (1998, 2011) conceptualisation of learning as embedded in communities of practice, where shared engagement and mutual support are critical to professional growth. In this context, digital marginalisation among older teachers may stem less from age than from exclusion from meaningful collaborative learning environments. Wilson et al. (2015) further assert that effective teacher learning is contingent on supportive contexts that foster inquiry, experimentation, and reflection conditions often absent in top-down ICT implementation schemes. In the same vein, Zimmerman (2022) argues that in the digital age, teacher education must be both adaptive and relational, empowering educators to engage with innovation through participatory, not prescriptive, means.

Conversely, while younger teachers may have constant exposure to technology, several studies show that they still demonstrate lower ICT self-efficacy. For example, Salomon and Ben-David Kolikant (2016) revealed that digital nativity does not necessarily translate into effective ICT use in pedagogy. Hargittai (2021) also supports this notion, indicating that while younger teachers may be familiar with ICT, they often lack the structured training required for its pedagogical application. These findings are aligned with Wenger's (1998) framework on *communities of practice*, which emphasises that mere exposure does not foster competence unless embedded in collaborative, reflective professional development structures.

According to Ertl, Csanadi, and Tarnai (2020), digital marginalisation remains a persistent challenge among older teachers who face difficulties adapting to rapid technological advancements. One teacher in their study shared, "There is an unspoken assumption that we should already know how to use these ICT platforms, but the reality is we need structured training just as much as our students" (adapted from Ertl et al., 2020). Similarly, Hatlevik and Hatlevik (2018) highlight that experienced teachers bring pedagogical depth that, when coupled with digital upskilling, results in a more balanced and innovative teaching approach. In this sense, Borko et al. (2008) argue that supporting diverse teacher profiles in

ICT adoption requires a flexible, adaptive model of professional learning that responds to the complex realities of practice.

Additionally, research suggests that age plays a defining role in digital inequality by reinforcing disparities in ICT access (Saikkonen & Kaarakainen, 2021; OECD, 2023). However, Kaarakainen and Saikkonen (2021) argue that rather than exacerbating generational divides, systemic efforts should focus on ensuring equal opportunities for all teachers to access digital tools and training. Kaarakainen, Saikkonen, and Savela (2019) further reveal that this challenge is particularly visible in Finnish schools, where a structured approach to professional development and mentorship can bridge generational gaps in ICT integration. Meanwhile, Kaarakainen et al. (2017) and Hatlevik (2017) note that older teachers often face compounded barriers due to limited digital exposure and inadequate professional development.

The findings of Drossel, Eickelmann, and Gerick (2017) and Fanni, Rega, and Cantoni (2013) reinforce the need for differentiated strategies that build upon the enthusiasm of younger teachers while capitalising on the pedagogical expertise of senior staff. In this regard, Wagemaker (2020) emphasises that digital readiness should be conceptualised not only as a matter of individual capacity but also of institutional accountability and systemic scaffolding. Moreover, as noted by Hämäläinen and Cincinnato (2015), their sentiment being Finnish teachers have emphasised that access to ICT alone is insufficient without ongoing support and mentoring to enable effective digital teaching.

Teacher Confidence and Digital Competence

Confidence in using digital tools plays an essential role in shaping teachers' willingness and ability to integrate ICT into classroom instruction. Research shows that teachers who perceive themselves as digitally competent are more likely to adopt interactive and student-centred teaching strategies (Hatlevik & Hatlevik, 2018; Drossel, Eickelmann, & Gerick, 2017). These findings highlight the value of sustained professional development initiatives that not only increase technical proficiency but also foster the confidence needed to use ICT creatively and effectively in educational contexts.
For example, Albion et al. (2015) emphasise that structured training programmes, mentorship, and leadership support are key to transforming ICT access into pedagogical impact. Similarly, Ertmer and Ottenbreit-Leftwich (2010) found that without adequate training and peer support, many teachers hesitate to move beyond basic ICT functions. In this context, attitudes toward ICT, often shaped by institutional scaffolding and teacher collaboration, can either encourage or inhibit innovation in teaching practices.
These insights are particularly relevant in Finland, where national education reforms promote digitalisation but decentralised governance places responsibility for implementation at the school level. Studies suggest that confidence in digital competence must be cultivated through targeted school-based initiatives, including mentoring programmes, peer learning, and leadership engagement (Eickelmann & Vennemann, 2017; Kaarakainen et al., 2019). Such measures are vital for ensuring that ICT integration is not only technically feasible but also educationally meaningful.

Consequently, fostering a positive professional culture around ICT through clear policies, continuous training, and collaborative learning environments is essential to enabling inclusive and sustainable ICT use in schools. As such, teacher attitudes and perceived readiness, while influenced by individual experience, are significantly shaped by institutional conditions that support continuous learning and innovation.

Teacher Professional Development and ICT Training: TPD

As Albion et al. (2015) argue, meaningful improvements in schools' adoption of ICT-supported education depend on teachers acquiring sufficient ICT proficiency. A study by Hatlevik and Hatlevik (2018) investigated the role of TPD in facilitating ICT use, instructional quality, and student performance in Finland. Their research found that structured TPD programmes positively influenced teachers' ICT self-efficacy and the frequency of ICT use in classrooms. These findings suggest that ongoing training plays a crucial role in building teachers' confidence and ability to integrate ICT effectively into pedagogical practices. Similarly, research by Zimmerman (2022) emphasises that innovations in teacher education during the digital age must go beyond surface-level digital tool exposure and instead focus on pedagogical fluency, supported by sustained professional development.

The Finnish education model emphasises continuous professional development rather than short-term, ad-hoc training, which often lacks depth and continuity. Research by Drossel, Eickelmann, and Gerick (2017) indicated that collaborative practices and sustained leadership support are essential for effective ICT implementation. The study highlighted that teacher collaboration and school-level support mechanisms significantly enhance engagement with digital tools. Additionally, Fanni, Rega, and Cantoni (2013) observed that professional development models tied to self-efficacy, especially when involving real classroom integration, sustain long-term engagement with ICT. In parallel, Borko et al. (2008) stress that professional development for technology integration must adopt an adaptive, reflective stance to respond to the 'wicked problems' of practice. This is reinforced by Hardré et al. (2013), who argue that interdisciplinary learning communities promote ICT experimentation through shared teacher inquiry, strengthening both content knowledge and teaching practices.

In addition to formal training, collaborative learning communities have been identified as critical to the ongoing adoption of ICT in schools. Research by McLaughlin and Talbert (2001) revealed that teachers who actively engage in professional communities and peer-to-peer learning programmes report significantly higher ICT integration compared to those reliant solely on external training. Furthermore, De Wever et al. (2015) emphasised that embedding TPD within a culture of continuous learning leads to sustainable ICT use and strengthens institutional ICT practices. Echoing this, Wilson et al. (2015) highlight that supportive institutional contexts are indispensable in sustaining teacher learning, especially in science education, where digital integration must align with complex curriculum standards. In support of these findings, Cozza (2022) underscores the importance of inclusive professional environments that enable continuous pedagogical evolution in response to digital transformation. Together, these insights suggest that effective teacher professional development must be systemic, inclusive, and aligned with broader institutional goals to ensure sustainable ICT integration.

Impact on Teaching Effectiveness

A study by Hatlevik and Hatlevik (2018) examined the role of teachers' self-efficacy in ICT use, particularly in STEM subjects such as mathematics and science. The study found that teachers who exhibit high levels of ICT self-efficacy are more likely to implement technology-driven activities that enhance student engagement and academic performance. Similarly, Sahlberg (2014) highlights that Finland's focus on digitalisation and project-oriented learning has created an enabling environment where ICT integration strengthens instructional effectiveness and facilitates interactive learning experiences. Complementing these findings, Musset (2015) asserts that Finland's emphasis on building

digital skills through sustained teacher support is a critical factor in improving pedagogical quality and ensuring digital equity across schools.

However, despite the benefits associated with ICT use in teaching, certain challenges persist. Rapanta et al. (2020) revealed that factors such as technostress and the rapid pace of ICT adoption particularly during the COVID-19 pandemic placed significant pressure on teachers, necessitating additional support structures. The study emphasised that continuous teacher training and professional development programmes are essential in equipping teachers with the necessary competencies to navigate evolving digital learning environments. Albion et al. (2015) and Hatlevik et al. (2017) further suggest that addressing these challenges through targeted training and institutional support can enhance teachers' effectiveness in ICT use, ensuring they can leverage technology to maximise learning outcomes in mathematics and science education. Additionally, the OECD (2023) survey underscores that improvements in digital pedagogy are most effective when embedded in broader systems of instructional reform, where technology use is aligned with curriculum goals and student-centred teaching strategies.

Barriers and Considerations

A study by Gil-Flores et al. (2017) identified limited infrastructure, insufficient training, and weak institutional support as key barriers to ICT integration in education, noting that such conditions make it difficult for many teachers to incorporate technology into their classroom practices. Similarly, Ertmer and Ottenbreit-Leftwich (2010) found that teachers often struggle with ICT integration because of time constraints and limited access to relevant resources.

Correspondingly, Nguyen et al. (2022) and Ertmer et al. (2012) highlight that even in technologically advanced regions, the absence of structured ICT training programmes significantly affects teachers' ability to adopt digital tools effectively. This issue is particularly pronounced in rural areas, where infrastructural deficits and inconsistent internet access create a digital divide that limits both student and teacher engagement with ICT (Ertl et al., 2020). As Kaarakainen and Saikkonen (2021) highlight, disparities in digital infrastructure particularly internet access and availability of digital tools pose significant challenges to equitable ICT integration, especially for students in rural areas. In consideration of these findings, Eickelmann and Vennemann (2017) argue that the disparity in digital resources often leads to lower self-efficacy among teachers, particularly those who have had minimal exposure to technology-enhanced instruction.

In addition, the rapid evolution of digital technologies presents a further challenge, as teachers may find it difficult to keep up with emerging tools and platforms. Hatlevik and Hatlevik (2018) found that teachers who do not receive continuous professional development in digital literacy are significantly less likely to integrate advanced ICT applications into their teaching practices. This underscores the importance of not only providing access to technology but also ensuring sustained training and mentorship to help teachers navigate the complexities of digital learning environments effectively.

Still on barriers, Tondeur et al. (2018) posit that addressing these challenges requires a multi-faceted approach, including targeted investments in digital infrastructure, comprehensive ICT training programmes, and the establishment of peer-support networks to cultivate a culture of collaborative learning and digital competence among teachers. Additionally, the OECD (2019a) and Lomos et al. (2023) emphasise that digital inequality can only be mitigated when structural policy reforms ensure coherence between curriculum, teacher training, and infrastructure development. As Arinushkina et al. (2023) further argue, managing the digital transition in education necessitates both methodological

innovation and institutional capacity-building an approach that remains unevenly implemented across school systems despite growing consensus on its importance.

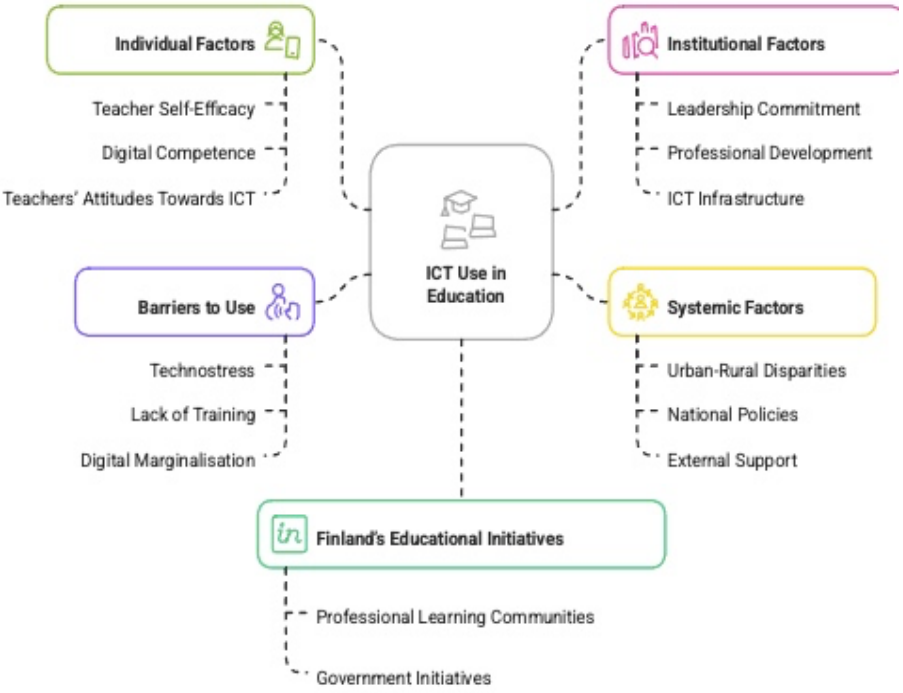
Summary

This chapter presents an integrative review as the adopted approach to synthesising existing studies on ICT adoption and teacher effectiveness. A total of 30 studies were reviewed, encompassing both individual and institutional factors impacting the integration of ICT in education. Studies examining classroom-level influences identified key factors affecting ICT adoption, such as digital competence, attitudes towards ICT, and pedagogical strategies for technology use. At the school level, leadership commitment, professional development programmes, and access to ICT infrastructure emerged as critical determinants of sustained digital integration.

Broader institutional and systemic factors highlighted disparities in ICT access between urban and rural schools, inconsistencies in national digital education policies, and variations in external support for technology-driven learning. The review also explored barriers to ICT adoption, including technostress, lack of continuous training, and challenges related to digital marginalisation among older teachers (see Figure 3). Additionally, studies focusing on Finland's education system underscored the role of structured PLCs and government-backed digital education initiatives in fostering ICT integration.

The literature review concludes with the identification of a research gap, emphasising the need for further empirical investigation into how institutional and individual factors interact to influence ICT-integrated teaching practices in schools. This study responds to that gap by examining how such factors shape teachers' capacity to use ICT in meaningful and pedagogically grounded ways within the Finnish education system.

Figure 3. *Factors Influencing ICT Use and Teacher Impact – Literature-Informed Flowchart.*



Research Gap

In contrast to previous studies that predominantly focus on individual teacher factors in ICT adoption, the current study takes a broader approach by incorporating institutional and systemic perspectives on ICT use in Finnish schools. While many studies, such as Nguyen et al. (2022) and Ertmer et al. (2012), examine teacher beliefs and digital competence as determinants of ICT adoption, fewer explicitly explore how institutional policies, school leadership, and digital infrastructure shape teachers' ability to use ICT effectively in their teaching. This thesis addresses that gap by analysing the role of institutional support, structured professional development, and leadership in enhancing ICT-integrated teaching practices. As highlighted by Carbonaro and Breen (2021), leadership clarity and cross-stakeholder collaboration are crucial for overcoming structural barriers to effective ICT adoption.

Furthermore, research on ICT integration in education frequently assumes that access to digital tools automatically results in improved instructional quality. However, studies such as Biagi and Loi (2013) challenge this assumption, revealing that access without ongoing training and strong institutional backing may not yield significant pedagogical benefits. Consistent with this, Rocha et al. (2024) emphasise the importance of aligning school-level leadership with national ICT strategies to ensure infrastructure investments translate into classroom application. This thesis contributes to the discourse by examining how institutional environments and teacher-level attitudes shape meaningful ICT use in instruction.

Although Finland's education system is internationally recognised for its digital literacy initiatives, little empirical research has examined how these initiatives translate into actual classroom practice. While professional development is often acknowledged as essential, the literature tends to overlook disparities in ICT use stemming from differences in school-specific resources and policies. This study extends the literature by examining how teachers navigate digital integration and whether institutional initiatives provide adequate support for sustained ICT-enhanced pedagogies. Drawing on findings from Mikheeva and Meyer (2020) and Lomos et al. (2023), the thesis investigates both systemic and pedagogical scaffolding required to bridge the gap between digital policy rhetoric and classroom realities.

In line with Zimmerman (2022), it was also observed that much of the research from around the past six years (2019–2024) has focused on professional development and training to improve digital competence. However, as Fraillon et al. (2020) and Cozza (2022) note, limited attention has been paid to how school-level leadership, infrastructure, and policy frameworks directly shape ICT-integrated practices. This thesis addresses that omission by examining both individual and institutional factors that influence how ICT is used in Finnish classrooms moving beyond assumptions about teacher readiness.

Finally, the selection of this study area was informed by recurring gaps in the literature. It challenges the assumption that young teachers, often labelled 'digital natives', inherently possess higher ICT proficiency. Emerging evidence (Hu, 2017; Kolikant, 2019) suggests that structured training and pedagogical scaffolding not generational familiarity are central to building digital competence. Supporting this view, Vejvoda et al. (2023) highlight the value of scenario-based training and reflective learning environments for both novice and experienced educators. By investigating the interplay between institutional conditions and individual teacher characteristics, this study offers a more grounded understanding of digital integration in Finnish schools. Its findings aim to inform actionable policies for more equitable and sustainable ICT adoption across diverse educational contexts.

Theoretical and conceptual framework

This chapter opens with a theoretical framework that offers a comprehensive overview of the subject under investigation and the potential relationships involved. Additionally, it establishes a broad conceptual foundation, setting the context for analyzing the subjects under study.

Theoretical framework

This chapter opens with a theoretical framework that offers a comprehensive overview of the subject under investigation and the potential relationships involved. Additionally, it establishes a broad conceptual foundation, setting the context for analysing the institutional and individual factors shaping ICT-integrated teaching practices.

This study adopts the perspective that learning is a dynamic process shaped by social interactions and cultural tools, rather than a direct result of teaching. Drawing on Vygotsky's (1978) Sociocultural Theory which emphasises that *"through others, we become ourselves"* (p. 56) this framework foregrounds the inherently social nature of learning. Within this paradigm, institutional and individual factors influence teachers' development not in isolation but through culturally and socially structured environments that mediate practice.

Learning and professional growth unfold within schools through tools such as digital platforms, collaborative structures, and PLCs. As Palincsar (1998) notes, learners acquire new strategies and knowledge through social participation, illustrating how collaborative interaction supports transformative learning. In this context, Vygotsky's concept of the Zone of Proximal Development (ZPD) becomes particularly relevant. ZPD refers to the distance between what a person can do independently and what they can achieve with guidance and support from more experienced peers or mentors. For teachers, this means that digital competence is enhanced when scaffolded by leadership, peer collaboration, and institutional support (Hatlevik & Hatlevik, 2018; Muukkonen et al., 2019).

Vygotsky (1978) also introduced the concept of mediation, where tools and signs transform the learner's interaction with the world. In this study's framework, stimuli include institutional inputs (e.g. leadership support, ICT policy, professional development) and individual dispositions (for example, attitudes toward ICT use). These factors operate as cultural artefacts technological and relational resources that mediate teaching practice. The corresponding response is the actual implementation of ICT-integrated teaching strategies that support student learning.

This socially embedded view of teacher development underscores that ICT-integrated teaching practices are not solely a function of access or competence but are shaped through the interplay of leadership, collaboration, and cultural norms within schools. The framework thus aligns with Vygotsky's core idea that higher-order thinking and development are fostered through mediated participation in shared activities whether face-to-face or in digital environments (John-Steiner & Mahn, 1996; Garzotto, 2007). It supports the interpretation that schools act not only as contexts of instruction but as sites of collective professional learning where digital pedagogy is developed, refined, and sustained.

Figure 3 offers a classification of institutional and individual factors affecting ICT use, informed by existing literature, while Figure 4 expands on this by reinterpreting these factors through Vygotsky's

Sociocultural Theory. This perspective regards ICT-related practices as socially influenced processes formed by leadership, collaboration, and professional learning contexts. Thus, rather than focusing on isolated psychological traits, the framework emphasises the cultural and organisational scaffolds that enable meaningful ICT integration.

Figure 3. *Stimulus–Response Triangle:* A Sociocultural Perspective on ICT Integration Adapted from Vygotsky's (1978, p. 40) concept of mediation, this model conceptualises institutional and individual factors as the stimulus influencing ICT-integrated teaching practices (the response) within socially and culturally mediated learning environments. Rather than focusing on internal psychological mediators, the triangle emphasises how external supports such as leadership, professional development, and collaboration act as scaffolds that shape pedagogical responses to technological change. This framework reflects a selective conceptual stance that foregrounds institutional context and teacher interaction with cultural tools (Brown & Green, 2019; Creswell & Poth, 2021; Pedhazur & Schmelkin, 1991).

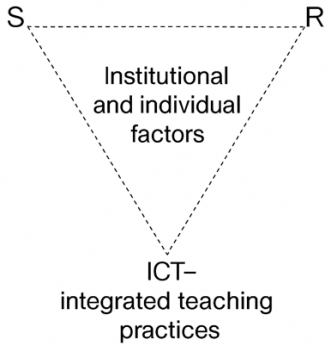


Figure 4. Stimulus–Response Triangle: A Sociocultural Perspective on ICT Integration

The Conceptual Framework

Understanding the essential principles of the selected theory is crucial. Although extensive research exists on teachers' use of ICT, several studies lack adequate theoretical foundations to comprehensively clarify how school surroundings impact technology integration (Hatlevik, 2017). This study fills the gap by utilising Vygotsky's Sociocultural Theory to analyse the interaction between institutional and individual factors that affect ICT-integrated teaching practices in Finnish schools.

In this context, institutional elements like leadership, professional development, and school-wide collaboration are regarded as social scaffolding that assist teachers in manoeuvring through the digital learning landscape. Individual characteristics, including teachers' views towards ICT and their readiness to participate in peer-supported innovation, are impacted by involvement in culturally organised environments. Vygotsky's (1978) concept of mediation clarifies how instruments (such as ICT) and social interactions (such as PLCs or mentoring) facilitate development. This study employs the Stimulus–reaction model, whereby institutional and individual factors serve as the stimulus, while ICT-integrated teaching operates as the response to it. The focus is on how these indicators interplay through collaborative and contextual dynamics to impact teaching practice.

This conceptual perspective aligns with literature asserting that teacher behaviour is influenced by institutional logics, resource availability, and community norms (Christensen, 2016; Elliott & Davis,

2019). This thesis emphasises the essential function of systemic frameworks and a collective professional culture in facilitating significant ICT integration. The approach emphasises school-based, relational, and policy-driven aspects over individual psychological characteristics that affect teachers' capacity to educationally integrate ICT resources.

Methodology

Introduction

This chapter provides an overview of the methodology utilized to analyse data for this study. According to Creswell and Creswell (2023), research methodology refers to the systematic process of gathering and analysing data to uncover patterns, trends, and relationships within a given field. Similarly, Sidhu (2014) describes research methodology as a structured framework of procedures, techniques, and strategies that guide the researcher in planning, designing, collecting, analysing, and interpreting data in response to the research question.

Quantitative Approach

This thesis employs a quantitative research methodology to thoroughly investigate the impact of institutional and individual factors on teachers' ICT-integrated practices in Finnish schools. Creswell (2014) asserts that a quantitative approach entails the empirical analysis of observable events by statistical, mathematical, or computational methods. This approach is ideal for hypothesis testing and analysing correlations between variables using quantitative data.

This section explores ways to make use of secondary data from the ICILS 2018 dataset, facilitating thorough statistical analysis to identify patterns, correlations, and relationships relevant to the research questions. It also addresses the measures implemented to guarantee reliable data and validity, as well as issues about study ethics and possible limits. Data analysis will utilise the Statistical Package for the Social Sciences (SPSS version 30.0).

Sample and Data

The International Computer and Information Literacy Study (ICILS) is an international survey conducted by the International Association for the Evaluation of Educational Achievement (IEA), first administered in 2013 and conducted every five years. The 2018 cycle, which is analysed in this research, represents the third iteration of the study. The primary aim of ICILS is to evaluate education systems globally by assessing students' computer and information literacy (CIL) and examining teachers' digital practices and professional development experiences. The population for the ICILS 2018 teacher survey comprised all lower secondary school (ISCED level 2) teachers instructing standard school subjects to students in grade 8 (or the nearest equivalent), with an average age of 13.5 years or older (Fraillon et al., 2019; OECD, 2023).

Furthermore, ICILS 2018 provided participating countries with the flexibility to administer optional teacher modules. In Finland, these included instruments on professional development, leadership support, ICT familiarity, teacher attitudes, and classroom ICT use. The survey instruments combined trend indicators and specific items, capturing both long-term patterns and detailed response data (e.g., demographic background and teaching experience). Many indicators were designed to measure latent constructs, using advanced psychometric techniques such as Item Response Theory (IRT) and Rasch Modelling. For example, ICILS 2018 applied these methods to derive standardised scales for

professional development participation, collaboration in ICT use, leadership support, and teacher attitudes toward ICT in education (Fraillon et al., 2020; IEA, 2020).

Moreover, to ensure data representativeness, ICILS 2018 employed a stratified two-stage probability cluster sampling design. In the first stage, schools were selected proportionally to their size based on the number of enrolled Grade 8 students. In Finland, this process yielded a nationally representative sample of 157 lower secondary (ISCED-2) schools. In the second stage, approximately 15 teachers were randomly selected from each participating school, producing a theoretical teacher sample frame of up to 2,355 teachers (Fraillon et al., 2020). However, the dataset file utilised for this thesis BTGFINI2.sav, obtained with SPSS version 30 contained a total of 1,853 teachers available for analysis (1,330 females and 523 males). This figure reflects the subset provided in the public-use data file, where records were already cleaned and structured by the IEA for secondary analysis. The author did not implement any further data exclusion or imputation techniques. Furthermore, teacher weight variables were applied to ensure unbiased national estimates and facilitate correct jackknife variance estimation, in accordance with ICILS 2018 analytical procedures (OECD, 2023). Globally, ICILS 2018 involved over 46 education systems and collected data from students, teachers, and school principals. The survey was conducted digitally and included optional modules related to professional development, ICT familiarity, and pedagogical practices.

Variables

To analyse how institutional and individual factors impact ICT-integrated teaching practices, it is essential to define the variables used in this study, based on the ICILS 2018 dataset. The variables were selected based on their alignment with the conceptual framework and existing research, ensuring that they represent validated indicators relevant to the thesis aim.

This thesis utilises the following terminological distinctions:

1. Observed Variables: Also known as measured or manifest variables, these are directly obtained through standardised instruments such as the ICILS 2018 teacher questionnaire. They signify visible behaviours or responses and serve as empirical indicators of broader educational constructs (Byrne, 2011; Kline, 2015; Ullman, 2006). In this thesis, observed variables include responses related to ICT use in teaching, participation in ICT-related professional development, collaboration with colleagues, leadership support for ICT, and teacher attitudes toward ICT, along with demographic characteristics.

2. Composite Variables (sometimes referred to as derived or scale variables): These variables represent broader conceptual constructs and were formulated by the ICILS research team using established psychometric procedures such as Item Response Theory (IRT) and Rasch modelling. While not directly measured, these constructs are statistically estimated from groups of observed responses. In this thesis, key composite variables include: ICT-Integrated Teaching Practices (ICT_ITEAP), Institutional Factors (including, leadership support [T_LSUP],, professional development [T_PROF], collaboration [T_COLICT], and Individual Factors (that is, teacher attitudes [T_ATTICT]).

These composite variables served as continuous predictors and outcome measures in the correlation and regression analyses designed to address Research Questions 1, 2, and 3. Their utilisation facilitates a theoretically grounded yet statistically manageable approach to assessing the complex dynamics of ICT

integration in Finnish schools. Descriptive statistics for all used variables are shown in *Table 1.* For more details*, see Appendix 1.*

Table 1 *Descriptive statistics and ICILS 2018 variable properties*

Variable	Construct	*N*	*M*	*SD*	*Range*		*Skewness*	*Kurtosis*
					Min	*Max*		
T_PROF	Average value of T_PROFSTR and T_PROFREC	1812	50.19	7.39	36.97	73.29	.26	–.07
T_COLICT	Teacher's collaboration in ICT usage	1812	48.52	9.21	22.90	71.53	. 22	.55
T_LSUP	Leadership support for ICT	1812	2.39	.53	19.18	71.75	–.07	.67
T_ATTICT	Teachers' attitudes towards ICT use Average of (T_VWNEG &T_VWPOS)	1812	47.88	4.09	33.43	78.78	.38	2.47
ICT_ITEAP	ICT_ integrated teaching practices. Average of (T_CLASACT, T-ICTPRAC and T-USETOOL)	1812	32.60	5.45	25.73	74.13	– .24	.96

Reliability and Validity

In educational research, including this thesis, ensuring high reliability and validity is essential to generating results that are trustworthy and generalisable. According to Golafshani (2003), reliability concerns the consistency of results across time and across samples, while Sullivan (2009) defines validity as the extent to which measurements reflect the desired constructs.

The ICILS 2018 dataset is internationally recognised for its diligent development, having undergone extensive quality control in translation, sampling, and measurement construction (IEA, 2020). The teacher questionnaire included in ICILS 2018 was created using psychometric procedures such as Item Response Theory (IRT) and Rasch Modelling to generate valid and reliable scale scores (Fraillon et al., 2020). Internal consistency for these scales was confirmed by the IEA through Cronbach's alpha, with benchmarks of $\alpha \geq .9$ (excellent), $\alpha \geq .8$ (good), and $\alpha \geq .7$ (acceptable). All constructs utilised in this thesis including ICT-integrated teaching practices, leadership support, professional development, teacher collaboration, and attitudes toward ICT meet or exceed these reliability thresholds.

Sampling procedures also adhered strict methodological criteria. The teacher population in Finland was sampled using a stratified two-stage design to ensure national representativeness. Teachers were selected from ISCED Level 2 schools, and sampling thresholds were implemented to minimise demographic bias and ensure sufficient statistical power. For more detailed information on the scale indices and reliability statistics, see the ICILS 2018 technical documentation (Fraillon et al., 2020, p. 256).

Teacher's Frequency of Participation in Professional Development: "T_PROF"

The ICILS 2018 collected teacher responses on ICT-related professional development through two distinct measures: T_PROFSTR, which assesses participation in structured training programmes, and T_PROFREC, which captures engagement in reciprocal learning experiences (Fraillon et al., 2020). These two components were averaged using SPSS to derive T_PROF, a composite measure reflecting the overall frequency of teachers' participation in ICT-focused professional development.
Teacher respondents were asked to report their engagement in ICT-related professional development over the past two years, with responses categorised on a three-point scale: 1 = "Not at all," 2 = "Once

only," and 3 = "More than once" (Fraillon et al., 2020). Higher scores on T_PROF indicate more frequent participation in professional learning activities. ICILS 2018 examined teachers' engagement in both structured and peer-based development through items such as "Participation in a course on ICT applications (e.g., word processing, internet use, databases)" and "Sharing of digital teaching and learning resources through collaborative workspaces" (Fraillon et al., 2020, p. 263). These were used to derive two subscales: T_PROFSTR and T_PROFREC, measuring structured and reciprocal learning respectively.

This integrated approach reflects the dual nature of ICT professional development in Finland, which combines formal coursework with collaborative peer learning. As noted by the Finnish Ministry of Education and Culture (2021) and Vuorikari et al. (2022), Finland's national strategy for teacher digital competence promotes both types of learning. EDUFI-funded training programmes aim to improve digital pedagogy and support innovation in technology-supported instruction.

Finally, the structured (T_PROFSTR) and reciprocal (T_PROFREC) components of ICILS 2018 are well aligned with Finland's ICT professional development paradigm, which emphasises teacher networks, collaborative lesson planning, and participation in PLCs (Vuorio et al., 2020). By incorporating T_PROF as an independent variable, this thesis assesses the role of professional development frequency in promoting ICT-integrated teaching practices in Finnish schools.

Teacher Collaboration: "T_COLICT"

Building upon sociocultural learning theories proposed by Wenger (1998) and Vygotsky (1978), which highlight the role of collaboration in cognitive development, this thesis incorporates T_COLICT as a measure of teacher collaboration in ICT use. The ability of teachers to learn from one another, share ICT-based resources, and observe best practices is critical in fostering effective ICT integration. Recognising this, ICILS 2018 included statements such as: "I observe how other teachers use ICT in teaching" and "I share ICT-based resources with other teachers in my school" (Fraillon et al., 2020, p. 261).

To measure teacher collaboration, responses were collected on a four-point Likert scale ranging from 1 ("strongly agree") to 4 ("strongly disagree"). These responses were reverse-coded so that higher values reflect greater levels of collaboration (Mikheeva & Meyer, 2020). This transformation ensures that all higher scores consistently indicate stronger engagement in collaborative ICT practices.

Furthermore, peer interaction and shared learning experiences are recognised as essential drivers of ICT competence development, particularly in professional environments that promote continuous growth. Analysing T_COLICT offers valuable insight into how collaborative teaching cultures influence the quality and frequency of ICT-integrated practices in Finnish schools.

Leadership Support for ICT Use: "T_LSUP"

Effective ICT integration in schools is significantly shaped by the support provided by leadership structures. In ICILS 2018, teacher perceptions of leadership support were captured through T_LSUP, a composite variable derived from T_RESRC (emphasis on ICT infrastructure) and T_ICTEMP (emphasis on ICT use expectations). These two components were combined after confirming internal reliability to represent overall administrative prioritisation of ICT in teaching (Fraillon et al., 2020).

Teachers responded to statements such as "ICT is considered a priority for use in teaching" and "School leaders encourage the use of ICT in teaching" using a four-point Likert scale (1 = "strongly disagree," 4 = "strongly agree"). These items reflect the perceived extent to which school leaders promote ICT

integration both as a policy priority and as a pedagogical expectation. Higher scores on T_LSUP indicate stronger leadership commitment to digital teaching strategies.

Leadership support is recognised as a key enabler of organised digital policies, access to infrastructure, and investment in teacher training (European Commission, 2021; Mikheeva & Meyer, 2020). In schools where leadership actively promotes ICT use, teachers are more likely to have access to relevant resources and feel encouraged to embed digital tools into their instructional practices. As such, this thesis incorporates T_LSUP as an independent variable to examine how institutional leadership emphasis influences ICT-integrated teaching in Finnish classrooms.

ICT-Integrated Teaching Practices: "ICT_ITEAP"

Teaching practices integrated with ICT are a critical factor in modern education, as they determine the extent to which digital tools enhance student engagement and learning outcomes. In light of findings from prior literature studies indicating the crucial role of ICT-supported instruction in fostering pedagogical innovation and improving student outcomes (Ilomäki et al., 2014; Hämäläinen & Cincinnato, 2015; OECD, 2023), this thesis employs ICT_ITEAP as the dependent variable. ICT_ITEAP captures teachers' ICT-integrated instructional practices aimed at enhancing student engagement, personalised learning, and access to enriched digital resources.

From the ICILS 2018 dataset, ICT_ITEAP is operationalised through a composite of three subscales: T_CLASACT, T_ICTPRAC, and T_USETOOL. These indicators measure the frequency and variety of ICT-based teaching activities, including the use of digital tools for instructional delivery, support for differentiated instruction, and facilitation of student access to information. These subscales include teacher-reported responses on a four-point Likert scale (1 = "Rarely" to 4 = "Always") (Fraillon et al., 2020). The responses were standardised by IEA, and their average was computed using SPSS to generate the overall ICT_ITEAP score, ensuring that higher values consistently indicate more frequent and integrated use of ICT in classroom instruction.

This composite approach aligns with the goal of capturing the multidimensional nature of ICT-integrated teaching across instructional delivery, individualised learning support, and student access to digital resources. ICILS 2018 examined ICT-integrated teaching practices through items such as "I use ICT to allow students to work at their own pace," "I use ICT to give students access to information and resources on the Internet," and "I use ICT to support students with different learning needs" (Fraillon et al., 2020, p. 201). These items form the basis of the ICT_ITEAP construct, enabling a comprehensive evaluation of how ICT is embedded into teaching practices.

Teachers' Attitudes Towards ICT Use in Education: "T_ATTICT"

In the context of results from previous literature highlighting the substantial impact of teacher perceptions in shaping ICT use, adoption, and pedagogical transformation (Ertmer et al., 2012; Redecker & Punie, 2020), this thesis examines T_ATTICT as an essential variable in understanding how attitudes toward ICT influence teaching quality and effectiveness. Teacher attitudes toward ICT use are widely recognized as a determinant of successful technology integration, influencing both instructional practices and student engagement.

ICILS 2018 surveyed teachers on their perceptions of ICT in education. Teachers were asked to express their level of agreement with statements about ICT's role in education using a four-point Likert scale

ranging from 1 *("Strongly disagree")* to 4 *("Strongly agree"),* which determined the extent of their attitudes toward ICT use (Fraillon et al., 2020). The responses were coded such that higher values indicate a more favourable perception of ICT in education, reflecting teachers' readiness to embrace technology-enhanced pedagogical practices (Mikheeva & Meyer, 2020; OECD, 2023).

T_ATTICT is operationalised through two primary constructs: T_VWNEG and T_VWPOS, developed by the IEA as part of the ICILS 2018 international dataset. In constructing the T_ATTICT composite variable, I first identified and extracted relevant items from both T_VWPOS *(positive views on ICT for example, "ICT enhances teaching quality")* and T_VWNEG *(negative views on ICT for instance, "ICT complicates instructional delivery").* I reversed the negatively worded items in T_VWNEG to ensure consistency in directionality, such that higher values reflected more favourable attitudes towards ICT. Then, I computed an average score across these using SPSS. This process yielded a unified composite variable, T_ATTICT, where higher values consistently represent more positive teacher attitudes toward ICT use and lower values reflect less supportive ICT integration perceptions.

Table 2 *A summary of adopted ICILS 2018 variables (Fraillon et al., 2020; Mikheeva & Meyer, 2020; IEA, 2020).*

Variable	Assessment	Example	Item #	Scale
T_PROF (IT2G17A) (Average value of T_PROFSR and T_PROFESC)	Teacher's frequency of participation in professional development related to ICT usage	A course on ICT applications (e.g., word processing, presentations, internet use, spreadsheets, databases)	5	1 (Not at all) to 3 (More than once)
T_PROFESC	'How often have you participated in any of the following professional development activities over the past two years? (T17) ICT use for lessons in subject domain'	Observations of other teachers using ICT in teaching	4	1 (Not at all) to 3 (More than once)
T_COLICT**	Frequency of ICT use for lesson planning; Collaboration between teachers on using ICT	How often do you use ICT for lesson planning?	4	1 (Never) to 4 (Always)
T_LSUP** (T_RESRC and T_ICTEMP)	Leadership support for ICT integration	Emphasis on ICT capabilities in vision statement or other governance at school	6	1 (Strongly disagree) to 4 (Strongly agree)
T_ATTICT**(T_VWNEG & T_VWPOS)	Teacher attitudes towards ICT use	ICT enhances teaching quality	7	1 (Strongly disagree) to 4 (Strongly agree)
ICT_ITEAP**	ICT_integrated teaching practices in class to facilitate individualised learning	Use of ICT to facilitate individualised learning	8	1 (Do not use) to 4 (Always)
T_CLASSICT, T_ICTPRAC and T_USETOOL	Approaches to Teaching: Use of ICT for teaching practices that support active learning and enable students to access better sources of information	Use of ICT to support active learning and better access to information		1 (Never) to 4 (Always)

Note. **: Higher values indicating higher level after recoded by ICILS 2018, Mikheeva & Meyer (2020); Shaded variables were merged to T_PROF,T_ATTICT,T-LSUP and ICT_ITEAP.

Examining Through Sustainable Development Perspectives

This thesis is positioned within the larger structure of Sustainable Development (SD), as established in the United Nations 2030 Agenda and its 17 Sustainable Development Goals (SDGs) (UN General Assembly, 2015). At the very foundation of this agenda is Education for Sustainable Development (ESD), which highlights the transformative potential of education to foster inclusive, equitable, and contextually relevant learning systems (De Wever et al., 2015; Dempsey et al., 2011). This study positions ESD as both a thematic backdrop and a conceptual thread that connects the investigation of ICT integration in education with overarching objectives of educational resilience, professional empowerment, and systemic innovation.

Informed by Vygotsky's Sociocultural Theory (1978), which views learning as a socially mediated process influenced by culture artefacts and interpersonal interactions, the thesis understands ICT as a cultural artefact a shared resource placed within sociotechnical contexts. Thus, variables like T_COLICT (collaborative ICT usage among educators) and T_PROF (ICT-related professional development) serve not just as operational indicators but also represent socially constructed behaviours that correspond with the ESD focus on systems thinking, equity, and empowerment. Rodríguez-Triana

et al. (2020) substantiate this perspective by emphasising the pivotal influence of school-level sociocultural factors on the formation of teachers' ideas and their attitudes towards ICT usage.

Appendix 2 presents an outline of key SDG indicators. This study is primarily aligned with SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 17 (Partnerships for the Goals) among the 17 Sustainable Development Goals (SDGs).

SDG 4: Quality Education is fundamental to this study's assertion that teachers' ICT self-efficacy substantially impacts the efficacy and sustainability of ICT-integrated pedagogies. This corresponds with previous data indicating that teacher competence directly influences learning equity, student outcomes, and pedagogical innovation (Hatlevik & Christophersen, 2020; Muukkonen et al., 2019; Fanni et al., 2013).

SDG 9: Industry, Innovation, and Infrastructure is examined in this research paper by investigating how institutional factors such as leadership support, ICT resources, and access to professional development facilitate or hinder educational innovation. The study corroborates the findings of Kaarakainen et al. (2019), who see investment in teacher training and infrastructure as essential catalysts for educational transformation.

SDG 17: Partnerships for the Goals is demonstrated through the study's use of the ICILS 2018 dataset, a cross-national, uniform evaluation approach. While ICILS does not represent a national statistics plan in itself, it illustrates Indicator 17.18.3 by facilitating rich, internationally comparable educational data to guide policy. The thesis emphasises the importance of global data relationships in fortifying national education plans and improving congruence with ESD objectives.

In sum, while SDG indicators are not directly measured, the thesis engages with them through proxy constructs and theoretical alignment. Thus, this study contributes not only to empirical understanding of ICT-integrated teaching practices in Finnish schools, but also reinforces the normative agenda of ESD by offering evidence-informed insights into how institutional conditions and teacher agency interact to support sustainable, inclusive educational innovation.

Analytical Process

This thesis applies a sequence of regression-based analytical techniques to examine the relationships between institutional and individual factors and ICT-integrated teaching practices. These techniques are grounded in both theoretical reasoning and empirical best practices (Pallant, 2020).

To establish a strong foundation for the framework, Pearson correlation analysis was first conducted to assess the strength and direction of linear associations between continuous variables. This step addressed Research Question 1 (RQ1), which examines the relationships between institutional and individual factors (T_PROF, T_COLICT, T_LSUP, and T_ATTICT) and ICT-integrated teaching practices (ICT_ITEAP). Correlation analysis enabled the identification of meaningful relationships between variables such as leadership support, professional development, and teacher attitudes, and the composite construct ICT_ITEAP derived from T_USETOOL, T_ICTPRAC, and T_CLASACT. As Pallant (2020) notes, preliminary correlation testing ensures that only statistically relevant variables are retained for subsequent modelling.

RQ2 was addressed using simple regression analysis to examine the individual effects of institutional and personal factors on ICT_ITEAP and finally, RQ3 was examined using multiple regression analysis to explore the joint influence of these predictors on ICT-integrated teaching practices.

Results

This section presents the results from the correlation and regression analyses performed to examine the thesis's core research questions (RQ1–RQ3) concerning the impact of institutional and individual factors on ICT-integrated teaching practices. As outlined in the methodology and analytical precision were maintained through preliminary statistical checks, including linearity and multicollinearity diagnostics. For clarity and transparency, the following summary table outlines general benchmarks for model quality, particularly those relevant to the interpretation of variance explained and predictor strength. These reference points offered guidance in evaluating the assessing of the statistical results.

Associations Between Institutional and Individual Factors and ICT Use

To address the first RQ, I conducted a Pearson correlation analysis using SPSS to examine the linear associations between the selected institutional factors (T_LSUP, T_PROF, T_COLICT), the individual factor (T_ATTICT), and ICT-integrated teaching practices, as captured by the composite variable ICT_ITEAP (comprised of T_CLASACT, T_ICTPRAC, and T_USETOOL). The results, presented in Table 4, revealed significant positive correlations between each of the institutional and individual variables and ICT_ITEAP, suggesting that higher levels of leadership support, professional development, collaboration, and positive attitudes toward ICT are each associated with greater integration of ICT in teaching practices. These findings provide preliminary empirical support for the inclusion of these variables in subsequent regression and moderation analyses.

As shown in Table 4, all institutional factors T_LSUP, T_PROF, and T_COLICT had statistically significant positive correlations with ICT_ITEAP, with the strongest correlation observed between leadership support and ICT_ITEAP ($r = .535$, $p < .001$). The individual factor, T_ATTICT, also showed a significant but weaker positive correlation ($r = .083$, $p < .001$). These findings suggest that higher levels of institutional support and more favorable individual attitudes are associated with greater implementation of ICT in classroom practice. Furthermore, T_PROF was positively correlated with T_COLICT, indicating ($r = .457$, $p < .001$.). This relationship was anticipated given that T_PROF represents an average of T_PROFSTR and T_PROFREC, the latter of which specifically captures reciprocal and collaborative ICT-related professional learning activities. These correlations further substantiate the theoretical pathways proposed in the model and support their visualization through path diagrams. The strength of these relationships reinforces their theoretical relevance and supports their inclusion in the regression and moderation models that follow.

Table 3 *Correlation matrix among of the ICILS 2018 variables*

	T_PROF	T_ATTICT	T_LSUP	ICT_ITEAP	T_COLICT
T_PROF	1	.034	.317**	.351**	.457**
Sig. (2-tailed)		.144	<.001	<.001	<.001
T_ATTICT	.034	1	.077**	.083**	.088**
Sig. (2-tailed)	.144		<.001	<.001	<.001
T_LSUP	.317**	.077**	1	.535**	.386**
Sig. (2-tailed)	<.001	<.001		<.001	<.001
ICT_ITEAP	.351**	.083**	.535**	1	.372**
Sig. (2-tailed)	<.001	<.001	<.001		<.001
T_COLICT	.457**	.088**	.386**	.373**	1
Sig. (2-tailed)	<.001	<.001	<.001	<.001	

** Correlation is significant at the 0.01 level (2-tailed): * Correlation is significant at the 0.05 level (2-tailed).

Predictors of ICT-Integrated Teaching

To address the second RQ, a series of simple linear regression analyses were conducted to evaluate the individual predictive power of institutional and individual factors on ICT_ITEAP. As shown in Table 5, each model was statistically significant, with all predictors contributing positively.

T_LSUP emerged as the strongest individual predictor, explaining 28.6% of the variance in ICT_ITEAP ($R^2 = .286$, $\beta = .535$, $p < .001$). This indicates that strong institutional backing plays a critical role in encouraging teachers to adopt ICT-based practices. T_COLICT also significantly predicted ICT_ITEAP ($R^2 = .139$, $\beta = .373$, $p < .001$), underscoring the role of peer support and shared practices. T_PROF showed a meaningful effect ($R^2 = .123$, $\beta = .351$, $p < .001$), suggesting that regular participation in ICT-related training enhances pedagogical integration. Lastly, T_ATTICT, although a statistically significant predictor ($R^2 = .007$, $\beta = .083$, $p < .001$), explained only a small proportion of variance in ICT-ITEAP, indicating a limited direct impact of beliefs when structural supports are absent. These findings support the theoretical proposition that while individual dispositions matter, structural and collaborative enablers play a more decisive role in shaping actual ICT-integrated teaching practice.

Table 4: *Simple Linear Regression Results Predicting ICT_ITEAP*

Predictor	Standardized Beta (β)	R Square (R^2)	F Value	Sig.	Interpretation
T_LSUP	.535	.286	734.935	<.001	Strongest predictor
T_COLICT	.373	.139	293.341	<.001	Moderate predictor
T_PROF	.351	.123	255.534	<.001	Moderate predictor
T_ATTICT	.083	.007	12.492	<.001	Weak predictor

Combined Impact of Institutional and Individual Factors on ICT Practices

To address the third RQ, a multiple linear regression analysis was conducted with ICT_ITEAP as the dependent variable. The independent variables included three institutional factors T_PROF, T_LSUP, and T_COLICT as well as one individual factor, T_ATTICT.

As shown in Table 6, the overall model was statistically significant, $F(4, 1803) = 222.474$, $p < .001$, and accounted for 33% of the variance in ICT_ITEAP ($R^2 = .330$; Adjusted $R^2 = .329$), indicating a substantial collective influence of these factors on teachers' ICT-integrated practices.

The standardised beta coefficients (β) revealed the relative contributions of each predictor. Leadership support (T_LSUP) was the strongest and most significant predictor ($\beta = .428$, $p < .001$), reaffirming the critical role of school leadership in enabling ICT adoption. Professional development (T_PROF) also showed a significant positive contribution ($\beta = .151$, $p < .001$), reinforcing the impact of structured ICT training. Collaboration among teachers (T_COLICT) contributed significantly as well ($\beta = .130$, $p < .001$), indicating that peer support mechanisms meaningfully facilitate ICT use. In contrast, attitudes toward ICT (T_ATTICT) did not significantly predict ICT_ITEAP ($\beta = .031$, $p = .107$), suggesting that favourable dispositions alone may not lead to practice change in the absence of institutional support.

Collinearity statistics indicated no multicollinearity concerns (Tolerance values > .6; VIF < 1.5), and collinearity diagnostics confirmed model stability, with no critical issues detected in eigenvalues or condition indices.

Table 5 *Multiple Linear Regression Results Predicting ICT_ITEAP*

Predictor	Std. Beta (β)	t	Sig. (p)	Tolerance	VIF
T_COLICT	.130	5.640	<.001	.694	1.441
T_PROF	.151	6.708	<.001	.735	1.361
T_ATTICT	.031	1.615	.107	.990	1.010
T_LSUP	.428	20.246	<.001	.830	1.205
*Model Summary: R = .575; **R^2** = .330; **Adjusted R^2** = .329; F(4, 1803) = 222.474, **p** < .001*					

Note: Tolerance values > .6 and VIF < 2 indicate no multicollinearity concerns. Collinearity diagnostics confirmed stable estimates with no critical variance inflation.

Discussion

This thesis aimed to examine how institutional and individual factors impact the ICT-integrated teaching practices of teachers in Finnish schools. Drawing on ICILS 2018 data, the findings are discussed sequentially based on each research question, highlighting agreements and tensions with existing literature and interpreted within the framework of Vygotsky's Sociocultural Theory. This study also responds to concerns raised by the OECD (2015, as cited in OECD, 2019b), which observed that "no appreciable improvements in student achievement in reading, mathematics, or science" were noted in countries investing heavily in ICT for education without accompanying pedagogical advancements. These findings underscore that digital infrastructure alone is insufficient without attending to the social and instructional contexts in which ICT is integrated.

The first research question explored the extent to which institutional and individual factors are correlated with ICT-integrated teaching practices. The analysis found that leadership support, professional development, and collaboration among teachers were significantly and positively correlated with ICT use in teaching, while teacher attitudes towards ICT showed a weaker relationship. These findings align with previous studies (for example, Albion et al., 2015; Kaarakainen et al., 2018) that emphasised the importance of structured leadership and continuous training in supporting meaningful digital integration.

Notably, the weak correlation between teachers' attitudes toward ICT (T_ATTICT) and ICT use confirms similar findings by Biagi and Loi (2013), who argued that favourable attitudes alone are insufficient for meaningful ICT adoption. Within Vygotsky's framework, this suggests that attitudes while reflective of an individual's internal motivation require institutional mediation to be translated into practice. The digital Zone of Proximal Development (ZPD) remains unreachable without leadership scaffolding, collaboration, and guided professional learning.

Additionally, the second research question evaluated whether these factors independently predict ICT-integrated teaching practices. The results confirmed that leadership support and professional development were the strongest individual predictors, with leadership support showing the highest standardised coefficient. Collaboration also contributed meaningfully, though to a slightly lesser extent. Teacher attitudes, however, contributed only marginally, reinforcing the notion that institutional supports outweigh personal disposition in driving digital transformation. These findings are consistent with Anderson & Dexter (2005) and Drossel et al. (2017), who showed that effective ICT adoption is closely linked to structural enablers rather than intrinsic motivation alone.

A critical reading of the limited predictive capacity of T_ATTICT reveals a valuable caution. While attitudinal constructs are often included in ICT models, their explanatory power in this study was minimal. Although past literature (for instance, Oleksandr, 2020) suggests attitudes matter, this study reveals that favourable perceptions of ICT if unsupported by strong leadership, training, and collaboration do not translate into effective classroom use. This result also points to a limitation in the ICILS measurement itself: the attitudinal indicators may not fully capture nuanced, context-specific teacher beliefs or readiness. This supports a call for mixed-methods approaches to complement large-scale surveys with deeper, qualitative data on motivational drivers.

Furthermore, the third research question assessed the combined impact of all institutional and individual predictors on ICT-integrated practices. Regression analyses indicated that these variables jointly explained approximately 36% of the variance in ICT use a meaningful figure in behavioural educational research. These findings led to the rejection of H_{03} and underscore the importance of an ecosystemic approach. That is, institutional and individual elements do not function in isolation; rather, their interaction fosters meaningful ICT integration.

Moreover, as outlined earlier in the theoretical framework, this study adapted Vygotsky's (1978) concept of mediation into a stimulus–response triangle, positioning institutional and individual factors as the stimuli and ICT-integrated teaching practices as the response. In this reconceptualisation, the mediating layer is not psychological (such as self-efficacy) but sociocultural, reflecting external scaffolds like leadership support, collaboration, and professional development. The findings of this study affirm the relevance of that model: it was not teachers' attitudes alone that predicted change, but the extent and quality of institutional scaffolding that shaped pedagogical responses to technological integration. This supports the view that meaningful ICT use is socially mediated embedded in structural conditions, collaborative norms, and professional cultures rather than simply emerging from internal motivation or access to tools.

This holistic perspective aligns with Drossel et al. (2017) and Kaarakainen et al. (2023), who advocated for systemic, multi-layered strategies for digital transformation. Unlike earlier models assuming technology access would be sufficient for change, the findings confirm that it is the interplay of leadership, collaborative environments, and targeted professional development that matters most. Within Vygotsky's sociocultural framework, this further highlights the role of schools as socially structured environments that mediate digital practices through cultural tools and collective action.

These findings carry important implications for ESD and the Sustainable Development Goals, particularly SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure). A digitally competent education system is not built solely through the distribution of devices or network access, but through sustained investment in people and institutions. Leadership development, peer mentoring, and inclusive policies are essential for ensuring that ICT serves as a meaningful pedagogical tool, rather than a symbolic intervention.

This study offers substantial insights, but several limitations must be acknowledged. First, the use of secondary data constrained the study's ability to probe into more qualitative or context-specific experiences of teachers. Secondly, the cross-sectional nature of the ICILS 2018 survey precludes any claims of causal inference. Third, while composite variables were statistically reliable, they may obscure subject-specific pedagogical variation or diverse ICT implementation models across schools. Fourth, although themes of digital equity and sustainability were theoretically embedded, they were not measured directly in this analysis. Thus, future research should employ longitudinal or mixed-methods designs to track how leadership, collaboration, and teacher beliefs evolve over time. Particular attention could be paid to post-COVID digital reforms, teacher workload, and rural-urban disparities in professional learning opportunities. Research could also examine how new digital platforms and AI-based technologies are reshaping professional development needs. Finally, student voice should be included to better understand how ICT-integrated practices influence engagement, inclusion, and learning outcomes.

These findings not only offer empirical insight into ICT-integrated teaching but also reaffirm the study's alignment with ESD goals, especially SDGs 4, 9, and 17, by showcasing the systemic and institutional conditions necessary to sustain inclusive and innovative educational practices.

Conclusion

Teachers in Finnish schools appear to benefit significantly from institutional and individual factors when it comes to ICT-integrated teaching practices. However, these benefits are not automatic. The results suggest that while access to digital tools and favourable teacher attitudes are present, it is leadership support, collaboration, and professional development that drive meaningful and sustained ICT integration. This raises critical questions for school leaders and policymakers about why technology investments alone often fail to translate into educational change.

The results affirm the importance of institutional scaffolding through leadership commitment, collaborative cultures, and professional learning opportunities in enabling teachers to effectively integrate ICT into teaching. Rather than relying on intrinsic motivation or enthusiasm for digital tools, successful ICT integration depends on structured and supportive environments that empower teachers to adapt and innovate within their instructional practices. Interestingly, the relatively weak predictive power of teachers' attitudes toward ICT use suggests that motivation without institutional structure may not lead to substantial change. This challenges common assumptions that positive attitudes are sufficient for digital transformation. Instead, the findings reinforce the need for integrated strategies where policy, infrastructure, and teacher development align.

Ultimately, the study underscores that while investing in ICT infrastructure is important, it is not enough. Schools must also invest in creating professional environments that cultivate collaboration and sustained professional development. This is essential not only for current teachers but also for future generations navigating evolving digital landscapes. If Finland is to maintain its global leadership in education, the focus must remain not just on technology access, but on fostering high-quality teaching environments where ICT becomes a meaningful tool for pedagogical advancement.

This thesis contributes to the understanding that institutional and individual factors are not peripheral conditions but central components influencing ICT-integrated teaching practices. It challenges the assumption that younger teachers (so-called "digital natives") are inherently more competent with ICT and highlights the importance of structured support and professional learning. By focusing on RQ1–RQ3, this thesis offers a clarified and coherent analysis of the institutional and individual conditions shaping ICT practices in Finnish schools. In doing so, it contributes to a more balanced understanding of ICT integration one that values teacher agency, institutional alignment, and strategic investment over simplistic solutions.

On the other hand**,** future research should address these limitations by employing longitudinal or mixed-methods designs to capture how institutional and individual conditions evolve over time, especially in response to systemic disruptions such as the COVID-19 pandemic. The pandemic significantly accelerated digital adoption, prompting urgent changes in institutional support and professional development. Understanding how these emergency responses shaped long-term practices, reduced inequalities, or exposed new ones would offer valuable policy insights. Future studies could also explore how contextual differences such as urban vs. rural settings, or varying leadership models affect the outcomes of ICT integration.

Lastly, as emerging technologies such as AI and adaptive platforms continue to evolve, future research should investigate how these tools influence teachers' professional development needs and reshape instructional practices. Including student perspectives would also deepen our understanding of how teacher ICT use impacts engagement and learning outcomes. Finally, aligning future research with the Sustainable Development Goals (particularly SDG 4 on Quality Education) will help ensure that digital transformations in education contribute meaningfully to broader goals of equity, inclusion, and sustainability.

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Appendices

A ppendix 1 + An overview of adopted ICILS 2018 items *(Fraillon et al., 2020; Mikheeva & Meyer, 2020)*

ICT_ITEAP: ICT-Integrated Teaching Practices (Dependent Variable) and T_ATTICT: Teachers' Attitudes Towards ICT Use in Education

Subscale Code	Subscale Label	Example Item from ICILS 2018	Response Scale	Data Handling and Source
T_CLASACT	ICT use for Classroom Activities	I use ICT to give students access to information and resources on the Internet.	1 = Rarely to 4 = Always	Teacher self-report; standardised scores provided by IEA.
T_ICTPRAC	ICT use for Pedagogical Practices	I use ICT to support students with different learning needs.	1 = Rarely to 4 = Always	Teacher self-report; standardised scores provided by IEA.
T_USETOOL	ICT use for Instructional Support	I use ICT to allow students to work at their own pace.	1 = Rarely to 4 = Always	Teacher self-report; standardised scores provided by IEA.
ICT_ITEAP	Composite of ICT-Integrated Practices	Composite measure based on T_CLASACT, T_ICTPRAC, and T_USETOOL	Continuous composite variable (standardised)	Averaged using SPSS by the author to compute overall ICT_ITEAP score. Higher values indicate more frequent and integrated use of ICT in instructional activities.
T_ATTICT	Composite of ICT Attitudes	Standardised and harmonised T_VWPOS and T_VWNEG composite measure	Continuous composite variable (standardised)	Author-built in SPSS by reversing T_VWNEG, standardizing items, and computing an average score. Higher values indicate positivity.

Variables	Item description	Response categories
Teacher's ICT self-efficacy (α = .84)		
T_ICTEFF	How well can you do these tasks using ICT?	
IT2G07A	Find useful teaching resources on the Internet	1 = I know how to do this 2 = I haven't done this but I could find out how 3 = I do not think I could do this
IT2G07B	Contribute to a discussion forum/user group on the Internet (e.g., a wiki or blog)	
IT2G07C	Produce presentations (e.g., [PowerPoint® or a similar program]) with simple animation functions	
IT2G07D	Use the Internet for online purchases and payments	
IT2G07E	Prepare lessons that involve the use of ICT by students	
IT2G07F	Using a spreadsheet program (e.g., [Microsoft Excel®]) for keeping records or analyzing data	
IT2G07G	Assess student learning	
IT2G07H	Collaborate with others using shared resources such as [Google Docs®], [Padlet]	
IT2G07I	Use a learning management system (e.g., [Moodle], [Blackboard], [Edmodo])	
T_PROFSTR: Teacher participation in structured learning professional development related to ICT (α = .83)		
T_PROFREC: Teacher participation in reciprocal learning professional development related to ICT (α = .78)		
T_PROF		
└ T_PROFSTR	How often have you participated in any of the following professional learning activities in the past two years?	1 = Not at all 2 = Once only 3 = More than once
IT2G17A	A course on ICT applications (e.g., word processing, presentations, internet use, spreadsheets, databases)	
IT2G17B	A course or webinar on integrating ICT into teaching and learning	
IT2G17C	Training on subject-specific digital teaching and learning resources	
IT2G17H	A course on use of ICT for [students with special needs or specific learning difficulties]	
IT2G17I	A course on how to use ICT to support personalized learning by students	
└ T_PROFREC	How often have you participated in any of the following professional learning activities in the past two years?	1 = Not at all 2 = Once only 3 = More than once
IT2G17D	Observations of other teachers using ICT in teaching	
IT2G17E	An ICT-mediated discussion or forum on teaching and learning	
IT2G17F	The sharing of digital teaching and learning resources with others through a collaborative workspace	
IT2G17G	Use of a collaborative workspace to jointly evaluate student work	

Collaboration between teachers in using ICT (α = .89)

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

ICT use expected of teachers (α = .89)

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

Appendix 2 + An overview of the thesis-relevant sustainable development goals *(Global Indicator Framework for the Sustainable Development Goals and Targets of the 2030 Agenda for Sustainable Development, 2024; Neshovski, 2015)*

SDG Goal(s)	***Target***		***Indicator***	***Content***
SDG 4 "Quality Education"				
	4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	4.4.1	Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill
	4.6	By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy	4.6.1	Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex
	4.7	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	4.7.1	Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education and (d) student assessment
	4.c.	By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States	4.c.1	Proportion of teachers with the minimum required qualifications, by education level

SDG 9 "Industry, Innovation, and Infrastructure"

9.c	Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020	9.c.1	Proportion of population covered by a mobile network, by technology

SDG 17 "Partnership for the goals"

17.8	Fully operationalize the technology bank and science, technology, and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology	17.8.1	Proportion of individuals using the Internet
17.14	Enhance policy coherence for sustainable development	17.14.1	Number of countries with mechanisms in place to enhance policy coherence of sustainable development
17.18	By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts	17.18.1	Statistical capacity indicators
		17.18.2	Number of countries that have national statistical legislation that complies with the Fundamental Principles of Official Statistics
		17.18.3	Number of countries with a national statistical plan that is fully funded and under implementation, by source of funding