International Journal of Innovative Research and Scientific Studies, 8(1) 2025, pages: 2009-2020

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Training of ICT for educational performance: A systematic review

Mujahid Hamood Hilal Alzakwani[1*], Shafie Mohamed Zabriv[2], Rabei Raad Ali[3]

[1,2]*Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Malaysia.*
[3]*Department of Computer Engineering Technology, Northern Technical University, 41000, Mosul, Iraq*.

Corresponding author: Mujahid Hamood Hilal Alzakwani (*Email: m.alzakwani81@gmail.com*)

Abstract

The purpose of this systematic literature review is to explore the role of digital competencies in teacher professional development and to identify research trends and future directions in this area, particularly in the context of the educational potential of Information and Communication Technologies (ICT). The review adhered to the PRISMA Statement Guidelines for Systematic Reviews and Meta-Analysis. It involved a comprehensive search of multiple databases, including ERIC, PubMed, Web of Science, Scopus, Emerald, and Taylor & Francis. The initial pool consisted of 169 studies, from which 23 were selected based on specific inclusion and exclusion criteria, thematic relevance, and the removal of duplicates. The majority of the selected studies utilized qualitative methodologies. The review revealed that digital competence is a significant challenge within the educational landscape. Most studies highlighted inadequacies in teacher training and insufficient ICT education, indicating a pressing need for enhanced digital competencies among educators. The findings pointed to a growing demand for ICT training and support to effectively integrate technology into teaching practices. The results suggest that educational institutions and policymakers should prioritize context-specific training and support for teachers in ICT competencies. By addressing the identified gaps in teacher training and providing targeted resources, it is possible to enhance the integration of technology in diverse learning environments, ultimately improving the quality of education and learning outcomes for students.

Keywords: ICT Education, ICT training, Performance, Performance, Training, Teachers.

DOI: 10.53894/ijirss.v8i1.4873
Funding: This research is supported by Universiti Tun Hussein Onn Malaysia (UTHM) Publisher's Office (Grant number: E15216).
History: Received: 1 January 2025/**Revised:** 4 February 2025/**Accepted:** 11 February 2025/**Published:** 21 February 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Institutional Review Board Statement: The Ethical Committee of the Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia (UTHM) has granted approval for this study.
Publisher: Innovative Research Publishing

1. Introduction

With rapid technological advancements and digitalization, Information and Communication Technologies (ICT) are increasingly important in enhancing the quality of life across various sectors. This is evident in different populations, where ICT solutions offer avenues for promoting well-being and independence. ICT can address the diverse needs of adults, including personalized healthcare, social inclusion, active aging, and independent living. This highlights the transformative power of technology to support and enhance the quality of life [1]. In modern education, ICT has emerged as an important enabler, offering innovative solutions to address traditional challenges and promote sustainable development goals in developing countries. As studies by Seegolam, et al. [2] indicate, ICT can expand access to quality education for marginalized populations, enhance teaching and learning through interactive and personalized approaches, facilitate collaboration and communication among stakeholders, and foster the development of essential 21st-century skills [3].

In terms of enhancing teaching and learning processes, ICT has increased student engagement and motivation through interactive tools, enabling differentiated instruction and personalized learning experiences. However, barriers to ICT adoption, such as limited access to technology, inadequate teacher training, and resistance to change, can all hinder its effective integration [4]. It was found that challenges to integrating ICT in language classrooms could include insufficient technical support and infrastructure, lack of teacher training and confidence, time constraints and curriculum demands, resistance to change, and equity issues. These obstacles reflect the challenges associated with ICT integration across education [5]. For instance, Nchunge, et al. [6] revealed a concerning underutilization of ICT in Kenyan secondary schools. This stems from limited ICT infrastructure and resources, inadequate teacher training and understanding of ICT's pedagogical applications, financial constraints related to cost and maintenance, and resistance to change favoring traditional teaching methods [6]. In addition, Gudmundsdottir and Hatlevik revealed that newly qualified teachers often face challenges related to inadequate training in digital competencies. Teachers might not only struggle to adapt to evolving technologies and methodologies but also lack confidence in their ability to effectively integrate ICT into their teaching [7].

Considering the important role of ICT in education and the factors associated with its integration in schools and teaching, this systematic review examined the role of ICT integration in education, focusing on the role of digital competence and teacher professional development. Recognizing that teacher preparedness is a decisive factor in the effective integration of ICT, and given the growing academic interest in this field, this review aimed to identify insights and research directions on this topic. This review aimed to understand how digital competence and teacher training were addressed in research, highlight emerging trends in ICT education over the last decade, and identify gaps to guide future research efforts and improve the effectiveness of technology integration in education across various settings.

2. Methods

The review was conducted following the principles of the Cochrane Handbook for Systematic Reviews of Interventions and was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [8].

2.1. Eligibility Criteria

2.1.1. Inclusion Criteria

The inclusion criteria for the systematic review were peer-reviewed journal articles published between 2014 and 2024, written in English, focused on education, available in full text through ERIC, and open access.

2.1.2. Exclusion Criteria

Articles were excluded from the review if they met any of the following criteria: duplicates, incomplete data, or lack of full-text information were grounds for exclusion. Additionally, publications such as reviews were excluded.

2.2. Search Strategy

The literature search was conducted across six databases—ERIC, PubMed, Web of Science, Scopus, Emerald, and Taylor & Francis—to gather relevant studies on ICT training in education. Specific search strings and filters were applied to ensure precision by excluding review articles and limiting results to English-language publications between 2014 and 2024. In ERIC, the search used the string "ICT Training" AND Education with filters to exclude reviews in the title and limit results to English. For PubMed, the search string was ((("ICT Training")) AND (Education)) NOT (review[Title]). In Web of Science, the query was TS=("ICT Training" AND Education) NOT TI=(review). The Scopus search applied TITLE-ABS("ICT Training" AND Education) AND NOT TITLE(review) with additional filters to exclude article reviews (DOCTYPE: "ar") and limit the language to English. In Emerald, the search string was (content-type: article) AND ("ICT Training" AND Education) - (title:"review"). Finally, the search in Taylor & Francis used [All: "ICT Training"] AND [All: Education] AND NOT [Publication Title: review] with filters to focus on education-related articles, restrict the publication type to articles, and set the publication date between 2014 and 2024.

2.3. Selection of the Studies

The processes of online searching, screening the titles and abstracts, as well as revising the full texts of relevant articles were conducted by two authors. Any disagreements were resolved by consensus.

Table 1.
Keywords and databases.

Database	Keywords
ERIC	"ICT Training" AND Education title: -Review language: english
PubMed	((("ICT Training")) AND (Education)) NOT (review [Title])
Web of Science	(TS= ("ICT Training" AND Education)) NOT TI=(review)
Scopus	TITLE-ABS (“ICT Training" AND education) AND NOT TITLE (review) AND (EXCLUDE (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))
Emerald	(Content-type: article) AND ("ICT Training" AND (Education) - (title:"review"))
Taylor & Francis	[All: "ict training"] AND [All: education] AND NOT [Publication Title: review] AND [All Subjects: Education] AND [Article Type: Article] AND [Publication Date: (01/01/2014 TO 12/31/2024)]

2.4. Data Extraction

Two authors independently extracted and recorded the following data: the study ID (author and year of publication), country, study design, population, settings, and results.

2.5. Measured Outcomes

Changes in teachers' attitudes, beliefs, digital literacy, technical skills, and their ability to use various ICT tools for pedagogical purposes.

2.6. Quality Assessment

We assessed the quality of the studies using the Critical Appraisal Skills Programme (CASP). The CASP checklist included specific criteria tailored to different types of studies. Each checklist consisted of a series of questions that guided users through the appraisal process, focusing on aspects such as study design, sampling, data collection methods, and ethical considerations [9].

3. Results

The selection and screening process followed the principles and adhered to PRISMA guidelines. The initial search yielded 169 relevant records based on keyword and MeSH term searches. After removing 11 duplicate records, the remaining 158 were screened based on their titles and abstracts. This initial screening excluded 100 records, resulting in 58 records for full-text screening. All relevant studies were read in full text by the author. A detailed review of the full-text articles excluded 35 records due to not meeting the inclusion criteria. Finally, 23 studies were included in the systematic review. The process of study screening through the PRISMA flowchart is illustrated in Figure 1.

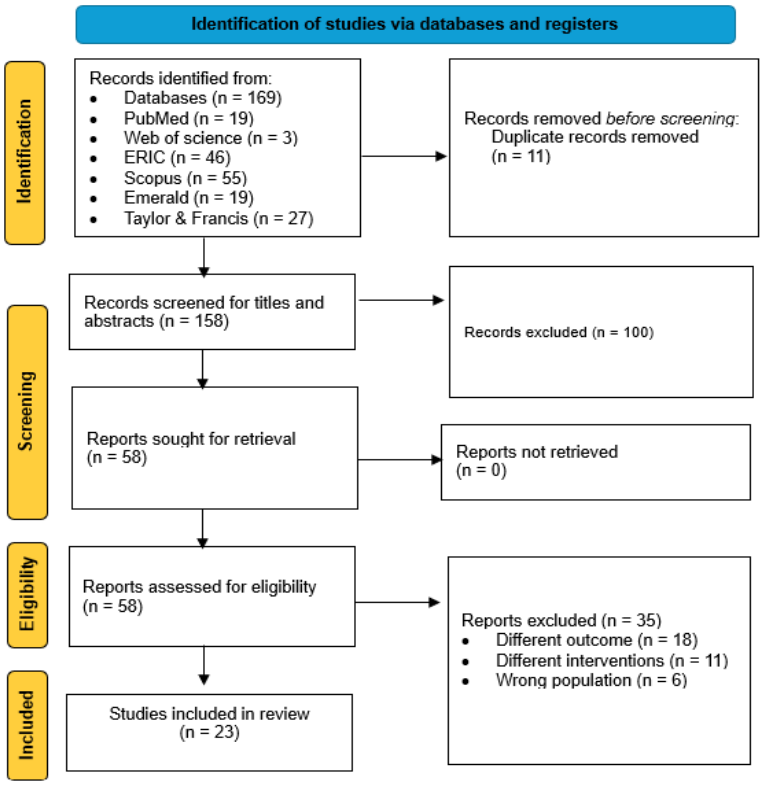

Figure 1.
PRISMA flowchart of the included studies.

Table 2.
Characteristics of the included studies.

Ref.	Aim	Results
Coşgun and Savaş [10]	To explore how in-service English teachers utilize the Internet for professional development, including the impact of teaching levels, ICT training, and the frequency of Internet use on collaboration and classroom practices.	• Most participants used the internet for professional development, with classroom practices being the most common application ($p < 0.05$). • Significant differences were found in collaborative internet use among teachers at different teaching levels (e.g., primary vs. university). • Teachers who used the Internet more frequently also utilized it more effectively for classroom practices ($p < 0.05$). • IICT training had a significant positive effect on teachers' use of the Internet for overall professional development and classroom activities ($p < 0.05$).
Nii, et al. [11]	To analyze the challenges that basic schoolteachers face when integrating ICT into teaching and learning activities and propose strategies to address these challenges.	• Limited ICT tools, a lack of power outlets, poor internet connectivity, and frequent power outages. • Teachers lacked adequate ICT training, and some preferred traditional teaching methods. • Inadequate ratio of ICT tools to students, with students often taking turns accessing equipment. • Improper handling of ICT tools leads to damage and malfunctions.
Mrosso and Ndibalema [12]	To explore teachers' perceptions of using ICT to enhance English language fluency and identify the challenges they face in integrating ICT into pedagogy.	• Grammar (30%) • Vocabulary (23.3%) • Accurate pronunciation (20%)
Anorue, et al. [13]	To explore the ways of empowering vocational educators for effective instructional delivery through Information and Communication Technology (ICT) training in tertiary institutions.	• ICT training is crucial for improving instructional delivery among vocational educators in Enugu State universities. • Key ICT skills identified as "very highly required" include word processing (mean = 3.69), spreadsheet skills (mean = 3.63), video conferencing skills (mean = 3.63), and creativity skills (mean = 3.72). • Challenges constraining ICT training include limited network accessibility (mean = 3.50), lack of qualified ICT personnel (mean = 3.26), and infrastructural impediments such as insufficient internet facilities and projectors (mean = 3.34).
Baytar, et al. [14]	To assess secondary school teachers' sense of competence regarding ICT use and to explore the impact of continuous training and the COVID-19 pandemic on teachers' perceptions of ICT integration.	• 26.1% of teachers felt effectively competent in using ICT. • The highest competence was observed at the Entry level (40%), followed by Adaptation (30.8%), and the lowest at Transformation (17.3%). • Continuous training ($p = 0.013$): Teachers who received ICT training felt more competent than those who did not. • Learning readiness ($p < 0.001$): Avid learners felt more competent than others. • Gender ($p = 0.009$): Males felt more competent than females. • New hires (1–5 years) felt more competent than more experienced teachers (16–25 years).
Canese, et al. [15]	To analyze the perspectives of Paraguayan English teachers regarding ICT integration in language education, particularly in the context of Emergency Remote Teaching (ERT) during the COVID-19 pandemic.	• Lack of institutional support, insufficient ICT training before the pandemic, and challenges in balancing pedagogy and technology. • Teachers with 0-5 years or 21+ years of experience encountered fewer ICT-related problems than those with 6-20 years of experience. • Preferred learning activities: Most teachers used a combination of synchronous and asynchronous tools. The most used platforms were Zoom and Google Meet, and WhatsApp was widely used for communication.

Ref.	Aim	Results
Gallardo-Montes, et al. [16]	To analyze the perception of ICT (Information and Communication Technologies) training among professionals working in the field of functional diversity in Granada.	• Participants had a favorable opinion of ICT, acknowledging its value in enhancing professional skills and improving the learning environment for individuals with functional diversity. • However, their perception of their own ICT training was medium to low, particularly in areas such as designing activities and using specialized educational software. • Younger professionals (20–30 years old) demonstrated significantly more favorable views and higher ICT competence compared to older professionals (51–64 years old).
Hughes, et al. [17]	To investigate the perception of digital training needs among pre-service language teachers, focusing on their competence in using ICT in language education and how frequently they employ digital tools in key areas of language teaching, as outlined by the Common European Framework Companion Volume (CEFR).	• ICT Training Gaps: Pre-service teachers felt underprepared for using ICT in teaching, with low initial ICT training scores (mean = 2.83). They identified a lack of training in key areas such as oral interaction, pronunciation, and mediation. • Positive Perception of ICT: Despite the gaps, participants viewed ICT as essential, recognizing its value in improving teacher-student interaction (mean = 4.43) and academic performance (mean = 4.23). • Frequent Use in Comprehension Skills: ICT was often utilized for oral and audio-visual comprehension, with mean scores of 4.03 and 4.17, respectively.
Sasere and Makhasane [18]	To examine how Adult Learning Theory (ALT) can be applied to address ICT skills gaps among educators in South Africa.	• The study proposed the use of ALT principles (self-concept, readiness to learn, intrinsic motivation, etc.) for designing effective ICT training for educators in South Africa. Recommendations include reforming teacher development policies, decentralizing ICT training, and conducting comprehensive ICT needs assessments.
Marín-Marín, et al. [19]	To analyze secondary school teachers' attitudes toward the development of good practices using augmented reality (AR) in education and identify factors that influence these attitudes.	• 40.13% of the teachers showed positive attitudes toward the use of AR in education. • Statistically significant differences were found in relation to factors like age, number of devices, time spent using technology, and teaching experience. • The analysis of various dimensions (e.g., satisfaction and reliability) showed a strong correlation between satisfaction and reliability in AR use.
Mateus, et al. [20]	To analyze teachers' perspectives on media education post-COVID-19 in Latin America and propose a critical agenda for addressing the challenges of media literacy and digital competencies in education.	• 90,000 students dropped out of school in Ecuador due to lack of technological tools, and 200,000 students moved from private to public schools. • In Peru, the school dropout rate reached 370,000 students, and private school enrollments decreased by 15%. • In Argentina, approximately 1 million students have dropped out of the education system.
Gómez-Fernández and Mediavilla [21]	To analyze the factors that influence teachers' decisions to use Information and Communication Technology (ICT) more or less frequently in classrooms.	• Teachers who received ICT training had a higher likelihood of using ICT in class (odds ratio: 1.302 for 3rd year, 1.787 for 6th year, and 1.242 for 4th year). • Frequent ICT use at home by students increased the likelihood of its use in the classroom (odds ratio: 3.234 for 3rd year, 9.582 for 6th year, and 4.765 for 4th year). • Lack of digital devices in schools reduced the likelihood of using ICT (odds ratio around 0.79 across levels)
Mendoza, et al. [22]	To determine the digital andragogical competencies of Ecuadorian higher education teachers during the COVID-19 pandemic.	• Training in ICT: Teachers need continuous ICT training to improve competencies such as digital literacy and effective communication. • Use of ICT in education: Teachers must develop critical and constructive communication through the effective use of ICT. • Attitude toward ICT: Teachers should foster a positive attitude toward ICT in higher education to enhance learning.

Ref.	Aim	Results
Paje, et al. [23]	The study aimed to determine the knowledge and practices of teachers in utilizing computer-based technology (CBT) in science instruction at two state-owned secondary schools in Zambales, Philippines.	• MS PowerPoint (mean: 3.56), MS Word (mean: 3.85), MS Excel (mean: 3.78), Google (mean: 3.63), and YouTube (mean: 3.73) were used "always." • MS Publisher (mean: 3.17) and Windows Media Player (mean: 3.37) were used "Often." • Microsoft Encarta (mean: 2.34) was used "Rarely". • Significant differences: • Presentation software usage varied by civil status and teaching experience, while educational software usage differed based on teaching position and educational attainment.
Hafıfah and Sulıstyo [24]	To investigate the ICT literacy levels of teachers in English Language Teaching (ELT) within higher education in Indonesia.	• The study found that over 60% of teachers have above-average ICT literacy and frequently use ICT in teaching, although they encounter challenges with internet access and limited ICT training.
Garzón, et al. [25]	To evaluate the level of digital competence among teachers in Lifelong Learning in Andalusia, Spain, and to explore factors influencing the development of digital teaching skills.	• The study found that teachers generally had low digital competence, with the most significant deficiency in digital content creation. Prior ICT training was linked to better performance in communication, collaboration, and content creation areas. • Age, teaching experience, and prior training were key factors influencing digital competence. The findings suggest a need for ongoing digital skill development in teacher training.
Fernández-Batanero, et al. [26]	To assess the level of ICT knowledge and training among physical education teachers for supporting students with disabilities and to examine factors influencing this training.	• The study found that physical education teachers generally have moderate knowledge of ICT for students with disabilities, with notable deficits in areas related to accessibility and support for visual impairments. • Factors such as gender, age, and years of teaching experience significantly impacted perceived ICT competence, with younger teachers and females reporting higher competence levels. Most teachers (88.85%) reported this.
Rueda and Cerero [27]	To identify the main barriers to ICT teacher training related to disability and to explore the perceptions of educational professionals regarding these barriers.	• The results indicated that the perceptions of barriers to ICT training were consistent across various types of educational centers.
Syahid and Nugraha [28]	To develop a training curriculum structure for primary school teachers to enhance their ICT skills.	• The study identified gaps in ICT skills among teachers and developed a structured training curriculum based on the UNESCO ICT Framework for Teachers, aimed at enhancing teachers' abilities to utilize ICT in education effectively.
Gil-Flores, et al. [29]	To investigate the factors influencing the use of ICT in Spanish secondary school classrooms, focusing on the relationship between teacher characteristics and ICT infrastructure.	• The study found that teacher characteristics, such as professional development needs, efficacy, collaboration, and beliefs regarding teaching and learning, are more significant predictors of ICT use in classrooms than the availability of ICT resources.
Kazan and EL-Daou [30]	To examine the relationship between science teachers' self-efficacy and their attitudes towards the integration of ICT.	• A significant correlation was found between teachers' technology background, attitude, self-efficacy, and students' academic performance, with a Pearson correlation coefficient of r = 0.6. • Teachers who underwent training demonstrated better ICT knowledge and integration, as well as higher attitudes and self-efficacy levels compared to those who were not adequately trained.
Akarawang, et al. [31]	To study the needs and training for enhancing ICT competency among teachers in the basic education system in Thailand.	• Most teachers lacked practical ICT skills, and current training programs were ineffective in supporting ICT integration in teaching. • Teachers expressed a preference for blended learning, which combines online and traditional training.

Ref.	Aim	Results
		• Key training gaps included a lack of assessments, outdated curricula, insufficient post-training support, and limited budgets.
Montoro, et al. [32]	To describe and analyze the ICT training received by faculty members in Spanish faculties of education.	• A significant proportion of faculty members relies on self-teaching and experimentation to develop ICT skills (79.4%). • 70% reported limited formal ICT training, with low participation in online or blended learning programs. • Professors indicated challenges in keeping pace with evolving technology, which led to gaps in the pedagogical use of ICT.

4. Qualificative Synthesis

The studies indicated the role of ICT in enhancing educational practices. A competency-based approach to teacher training enabled educators to develop the necessary skills in ICT, communication, and pedagogy for effective virtual education. However, many teachers reported low to moderate levels of ICT competency. Factors such as teachers' perceptions of ICT's pedagogical usefulness, prior training, and demographic variables significantly impact their ICT use. Common barriers, including insufficient training opportunities and resources, as well as negative attitudes toward technology, have also affected ICT integration.

4.1. ICT Competencies and Teacher Training

The included studies converge on the critical role of ICT competency for educators in the 21st century. This competency is not just about technical skills but encompasses knowledge, skills, and attitudes that enable educators to effectively use technology for pedagogical purposes. This was evident by, Mendoza, et al. [22] and Syahid and Nugraha [28] who showed that there is a need for a more focused understanding of ICT competency. In addition, the research underscored the significant impact of well-designed ICT training on educators' confidence, attitudes, and practices. For instance, Kazan and EL-Daou [30] demonstrated the link between consistent ICT training and increased technology self-efficacy among teachers. However, some limitations emerged from generic training approaches. Akarawang, et al. [31] identified several challenges in ICT training, including a lack of needs assessment, inadequate resources, and insufficient post-training support [31]. It seems that there is a persistent digital divide among educators, as some studies such as Garzón, et al. [25] revealed low levels of digital competence among specific groups of teachers. This divide is further accentuated by factors such as gender, age, and years of experience, as found by Gallardo-Montes, et al. [16]. It was found that there is a need to consider the specific context in which ICT is being integrated. For instance, Hughes, et al. [17] explored the use of digital tools for language skills development, highlighting the importance of aligning technology with pedagogical goals and learner needs [17]. Similarly, Gallardo-Montes, et al. [16] focused on educators working with individuals with functional diversity and found that there is a need for specialized training and resources to support inclusive practices [16]. It is worth noting that there is a shift from a technical view of ICT to a more holistic perspective that recognizes the social, cultural, and ethical dimensions of technology integration. Mendoza, et al. [22] highlighted the importance of "knowing how to be" and "knowing how to live together" in the digital age, indicating the role of ICT in improving collaboration, communication, and ethical digital citizenship.

4.2. Impact Of COVID-19 on Education

The COVID-19 pandemic forced a rapid shift to remote learning, thrusting ICT into the forefront of educational practices. This accelerated integration exposed both the potential and the limitations of technology in education. While ICT enabled continuity of learning during school closures, it also revealed disparities in access, skills, and resources [12, 20]. The studies underscored the link between ICT competence and teacher confidence in remote learning environments. Baytar, et al. [14] found that around 26.1% of teachers felt effectively competent in ICT use, emphasizing the need for targeted training to enhance teachers' digital skills and confidence [14]. In addition, Canese, et al. [15] revealed that prior ICT training and teaching experience were significant factors influencing teachers' ability to adapt to remote teaching. Furthermore, the pandemic exacerbated challenges in education in under-resourced contexts. For instance, Mateus, et al. [20] highlighted the lack of training and increased workload faced by teachers in several Latin American countries. Additionally, Mrosso and Ndibalema [12] indicated that similar challenges were found among the Tanzanian population, emphasizing the limitations imposed by inadequate infrastructure and insufficient training.

4.3. Barriers to ICT Integration

Significant teacher-related barriers were discovered in the included studies. For instance, Nii, et al. [11]identified inadequate training opportunities, lack of technical support, and negative attitudes toward ICT as key challenges faced by elementary school teachers in Ghana. Similarly, Rueda and Cerero [27] found a lack of teacher awareness and preparation regarding ICT use for students with disabilities in Spain. These two studies identified a lack of institutional support as a major obstacle to ICT integration. In Ghana, this manifested in insufficient infrastructure and large class sizes, which hindered effective technology use in classrooms. In Spain, the lack of institutional support was evident in the limited training opportunities and resources available to teachers, particularly in the context of inclusive education. While both studies identified the barriers, they also provided glimpses into the reasons behind these barriers. In Ghana, negative attitudes toward

ICT may have stemmed from a lack of understanding of its pedagogical potential or fear of technology. In Spain, the lack of awareness and preparation regarding ICT use for students with disabilities may have reflected a broader lack of focus on inclusive practices in teacher training and education systems.

4.4. Teachers' Perceptions and Attitudes Toward ICT

Regarding teachers' perceptions and attitudes toward ICT, Gil-Flores, et al. [29] and Gómez-Fernández and Mediavilla [21] highlighted the significance of perceived pedagogical usefulness as a driver of ICT integration [21, 29]. When teachers believed that technology could enhance their teaching and improve student learning outcomes, they were more likely to embrace and use it in their classrooms. The availability of infrastructure and supportive school policies also played a role in shaping teachers' perceptions and attitudes towards ICT. Gil-Flores, et al. [29] emphasized the positive association between infrastructure availability and ICT use frequency. On the other hand, Gómez-Fernández N. revealed that factors such as teacher gender, years of experience, and prior ICT training also influenced technology use [21, 29].

Moreover, Marín-Marín, et al. [19] focused on the specific context of Augmented Reality (AR), finding that teachers with higher levels of perceived self-efficacy, satisfaction with technology use, and digital competence were more prone to have positive attitudes toward using AR in their teaching. In addition, Coşgun and Savaş [10] demonstrated that teachers recognized the value of using the internet for professional development, collaboration, and staying updated on pedagogical practices [10]. Regarding professional needs, studies indicated the role of teachers as agents of change in driving ICT integration. By providing teachers with access to diverse training opportunities and equipping them with the necessary skills, technology can be used to enhance teaching and learning experiences. Montoro, et al. [32] revealed that faculty members engaged with ICT training through various channels, including formal programs (b-learning and e-learning) and informal learning experiences (self-teaching and experimentation). While technical skills were essential, they were not sufficient for effective ICT integration. For instance, Sasere and Makhasane [18] emphasized the role of pedagogical strategies in facilitating technology use in multigrade classrooms, advocating for professional development that addresses the specific pedagogical needs of teachers in these settings. A significant knowledge deficit among Physical Education teachers was discovered by Fernández-Batanero, et al. [26] in Spain regarding the use of ICT with students with disabilities. While teachers perceive themselves as moderately trained, they lack specific knowledge and skills necessary to effectively leverage technology to support inclusive education practices. Interestingly, Fernández-Batanero, et al. [26] found that younger and more experienced teachers reported greater knowledge about ICT use with students with disabilities.

Table 3.
Assessment of the quality of the included studies.

Domain	Assessment																					
	Nii, et al. [11]	Mrosso and Ndibalema [12]	Anorue, et al. [13]	Baytar, et al. [14]	Canese, et al. [15]	Gallardo-Montes, et al. [16]	Hughes, et al. [17]	Sasere and Makhasane [18]	Marín-Marín, et al. [19]	Mateus, et al. [20]	Gómez-Fernández and Mediavilla [21]	Mendoza, et al. [22]	Paje, et al. [23]	Hafifah and Sulistyo [24]	Garzón, et al. [25]	Fernández-Batanero, et al. [26]	Rueda and Cerero [27]	Syahid and Nugraha [28]	Gil-Flores, et al. [29]	Kazan and EL-Daou [30]	Akarawang, et al. [31]	Montoro, et al. [32]
Objectives	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L
Methodology	L	L	M	L	L	M	L	H	M	M	L	L	L	M	M	M	L	M	L	M	M	M
Recruitment strategy	M	M	H	M	M	M	M	NA	M	M	L	M	M	M	L	M	L	L	L	M	H	M
Data collection	L	L	L	L	L	M	M	H	M	M	M	M	M	M	L	L	L	L	L	M	M	M
Reflexivity	M	M	H	H	H	M	M	NA	NA	L	NA	H	H	M	M	H	M	L	M	L	H	H
Ethical considerations	L	L	M	L	L	L	M	NA	L	L	L	M	L	M	M	M	L	M	M	M	M	M
Data analysis rigor	M	L	L	L	L	L	L	H	M	M	L	L	L	M	L	M	L	L	L	L	M	M
Clarity of findings	L	L	L	L	L	L	L	M	L	L	L	L	L	M	L	L	L	L	L	M	L	L
Generalizability	L	L	L	L	L	L	M	L	M	H	M	M	M	L	M	M	H	L	L	L	H	M

Note: Low = L; Moderate=M; High= H; Not Available.

5. Discussion

This systematic review of the included 23 studies examined the integration of ICT in education across diverse geographic, cultural, and institutional contexts. While ICT presented significant opportunities for enhancing teaching and learning, the review revealed important enablers, barriers, and disparities. The studies highlighted that teacher training was crucial for successful ICT integration. For instance, Gómez-Fernández and Mediavilla [21]; Syahid and Nugraha [28]; and Baytar, et al. [14] found that prior ICT training increased teachers' likelihood of using technology in classrooms, focusing on the importance of continuous professional development. Interestingly, Mendoza, et al. [22] demonstrated that both training and positive attitudes toward ICT significantly improved educators' digital competence. Teachers trained for over 10 hours experienced fewer ICT-related challenges [15], indicating that both the duration and frequency of training affect the outcomes. This was consistent with findings from Kumar, P, which found that integrating ICT into teacher training resulted in enhanced educational quality [10]. However, current training programs remain inadequate in many regions.

For instance, Akarawang, et al. [31] reported that ICT training often lacked practical relevance, as teachers in Thailand expressed a preference for blended learning programs. Similarly, Montoro, et al. [32] noted that many educators resort to self-teaching, as institutional training programs are outdated or insufficient. In addition, Syahid and Nugraha [28] stressed the need for training aligned with frameworks such as UNESCO's ICT Competency Standards to enhance effectiveness [28]. Access to ICT resources emerged as a factor influencing usage. Gómez-Fernández and Mediavilla [21] found that frequent ICT use at home increased its application in classrooms, but limited access to digital devices within schools reduced usage across all levels. Studies conducted by Nii, et al. [11] and Hafıfah and Sulıstyo [24] also revealed persistent issues with insufficient equipment, unstable internet connectivity, and frequent power outages, limiting the use of ICT. This was also evident in another study conducted by Muriithi, which showed that a range of factors affected ICT adoption and use in research collaborations, including access to resources, the nature of research work, the ICT and research environment in the country and institutions, and the socio-cultural practices of researchers [11].

Moreover, the lack of equitable access had consequences for education. In Latin America, Mateus, et al. [20] reported that inadequate technology access contributed to school dropouts, with Argentina, Ecuador, and Peru experiencing significant declines in student enrollments. These findings highlighted that digital inequity exacerbated educational disparities. Teacher characteristics, including age, gender, experience, and subject expertise, influence ICT adoption patterns. For instance, Baytar, et al. [14] found that younger teachers (aged 20-40) reported higher ICT competence than older educators. This was similarly observed by Fernández-Batanero, et al. [26]. Gender differences were assessed, with males feeling more competent in ICT use than females, while the opposite was true in physical education in Spain [14, 26]. In terms of experience, new hires and less-experienced teachers exhibited higher confidence in ICT use [14, 15] due to exposure to newer technologies during their training. These findings may suggest that specific demographic and subject needs could improve ICT adoption rates.

Furthermore, infrastructural, policy, and institutional challenges limit the effective use of ICT. Teachers in Ghana Nii, et al. [11] and Tanzania [12] reported issues such as outdated software, poor connectivity, and insufficient digital devices. Additionally, Canese, et al. [15] found that the lack of institutional support, especially during the pandemic, hindered the integration of digital tools into teaching practices. This was also evident in the work of Fernández-Batanero, et al. [26], who noted a severe lack of ICT training tailored for students with disabilities, with 88.85% of teachers receiving no formal preparation in this area. It was found that policy frameworks were also misaligned with educators' needs. For instance, Akarawang, et al. [31] identified several gaps, such as the absence of needs assessments and insufficient post-training support, which limit the effectiveness of training programs Akarawang, et al. [31]. Sasere and Makhasane [18] recommended decentralizing ICT training in South Africa and aligning it with adult learning principles to foster teacher engagement. Without supportive policies and adequate resources, teachers face difficulties balancing technology integration with their pedagogical responsibilities [15, 32].

This was consistent with findings by Ertmer PA et al., which indicated that the biggest barriers to technology integration practices and the strongest enablers were internal (attitudes, beliefs, knowledge) [12]. Despite these challenges, many studies highlighted the positive impact of ICT on teaching practices and student outcomes. Teachers reported that ICT enhanced learning by improving student engagement, retention, and comprehension [12, 17]. Specifically, tools like Zoom, Google Meet, and WhatsApp facilitated both synchronous and asynchronous learning [15]. Several studies also emphasized the value of ICT in improving language skills. Mrosso and Ndibalema [12] found that ICT tools significantly improved students' grammar, vocabulary, and pronunciation. Similarly, Hughes, et al. [17] found that ICT was used to develop oral and audiovisual comprehension, although there was limited use for enhancing interaction skills. Furthermore, studies discussed emerging technologies that might further enhance education. Marín-Marín, et al. [19] explored the use of augmented reality (AR) and found that teachers' satisfaction and reliability with AR tools were strongly correlated. However, only 40.13% of teachers expressed positive attitudes toward AR, indicating a need for further training and resource development in this area. Future research should explore the use of innovative tools such as AR and artificial intelligence (AI) to bridge existing pedagogical gaps.

6. Conclusion

This review highlighted the multifaceted role of ICT in education and the factors influencing its integration. While ICT offered significant pedagogical benefits, its effectiveness depended on the availability of training, infrastructure, and policy support. A key finding highlighted in the majority of the selected studies is the inadequacy of teacher training and insufficient ICT education. Addressing disparities in access and ensuring continuous professional development are essential to achieving

equitable and effective ICT use. Future efforts should focus on emerging technologies such as AR and AI to bridge existing pedagogical gaps and enhance teaching and learning.

References

[1] S. Baraković *et al.*, "Quality of life framework for personalised ageing: A systematic review of ICT solutions," *International Journal of Environmental Research and Public Health*, vol. 17, no. 8, p. 2940, 2020. https://doi.org/10.3390/ijerph17082940

[2] A. Seegolam, A. Sukhoo, and V. Bhoyroo, "ICT as an enabler to achieve sustainable development goals for developing countries: A proposed assessment approach," in *eChallenges e-2015 Conference*, 2015: IEEE, pp. 1-11.

[3] A. Sucipto, A. K. Zyen, B. B. Wahono, T. Tamrin, H. Mulyo, and R. R. Ali, "Linear discriminant analysis for apples fruit variety based on color feature extraction," in *2021 International Seminar on Application for Technology of Information and Communication (iSemantic)*, 2021: IEEE, pp. 184-189.

[4] J. E. Lawrence and U. A. Tar, "Factors that influence teachers' adoption and integration of ICT in teaching/learning process," *Educational Media International*, vol. 55, no. 1, pp. 79-105, 2018. https://doi.org/10.1080/09523987.2018.1439712

[5] R. R. Ali, K. M. Mohamad, S. Jamel, and S. K. A. Khalid, "Classification of JPEG files by using extreme learning machine," in *Recent Advances on Soft Computing and Data Mining: Proceedings of the Third International Conference on Soft Computing and Data Mining (SCDM 2018), Johor, Malaysia, February 06-07, 2018*, 2018: Springer, pp. 33-42.

[6] D. M. Nchunge, M. Sakwa, and W. Mwangi, "User's perception on ICT adoption for education support in schools: A survey of secondary school teacher's in Thika district Kenya," *International Journal of Humanities and Social Science*, vol. 2, no. 10, pp. 17-29, 2012.

[7] G. B. Gudmundsdottir and O. E. Hatlevik, "Newly qualified teachers' professional digital competence: Implications for teacher education," *European Journal of Teacher Education*, vol. 41, no. 2, pp. 214-231, 2018. https://doi.org/10.1080/02619768.2017.1416085

[8] A. Liberati *et al.*, "The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration," *Annals of Internal Medicine*, vol. 151, no. 4, pp. W-65-W-94, 2009. https://doi.org/10.2427/5768

[9] H. A. Long, D. P. French, and J. M. Brooks, "Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis," *Research Methods in Medicine & Health Sciences*, vol. 1, no. 1, pp. 31-42, 2020. https://doi.org/10.1177/2632084320947559

[10] G. E. Coşgun and P. Savaş, "Enhancing teaching skills of in-service English teachers through online professional development," *Journal of Learning and Teaching in Digital Age*, vol. 9, no. 1, pp. 32-39, 2024. https://doi.org/10.53850/joltida.1248625

[11] A. N. J. Nii, R. Osei Mensah, R. Asafo-Adjei, and P. Adiza Babah, "Analyzing the challenges basic school teachers face in integrating information and communication technology into teaching and learning activities in a developing country," *Cogent Education*, vol. 11, no. 1, p. 2364544, 2024. https://doi.org/10.20944/preprints202312.0650.v1

[12] V. Mrosso and P. Ndibalema, "Teachers' perceptions on the role and challenges of using ICT in English language classrooms," *International Journal of Technology in Education and Science*, vol. 8, no. 1, pp. 121-137, 2024. https://doi.org/10.46328/ijtes.527

[13] H. C. Anorue, J. E. Ekuma, T. O. Olinya, and L. O. Nwandu, "Empowering vocational educators instructional delivery through information and communication technology training in universities," *Journal of Education and Learning (EduLearn)*, vol. 17, no. 4, pp. 555-565, 2023. https://doi.org/10.11591/edulearn.v17i4.20311

[14] E. M. Baytar, H. Elyacoubi, N. Saqri, and L. Ouchaouka, "Teachers' sense of competence in terms of ICT use: The case of secondary school teachers," *Research in Learning Technology*, vol. 31, 2023. https://doi.org/10.25304/rlt.v31.2874

[15] V. Canese, R. Paez, and J. Amarilla, "Critical issues in the English language classroom: ICT and online learning in language education," *International Journal of Technology in Education*, vol. 6, no. 1, pp. 84-99, 2023. https://doi.org/10.46328/ijte.312

[16] C. d. P. Gallardo-Montes, M. J. Caurcel-Cara, E. Crisol-Moya, and P. Peregrina-Nievas, "ICT Training perception of professionals in functional diversity in Granada," *International Journal of Environmental Research and Public Health*, vol. 20, no. 3, p. 2064, 2023. https://doi.org/10.3390/ijerph20032064

[17] S. P. Hughes, S. Corral-Robles, and J. L. Ortega-Martín, "Let's get digital: ICT training needs in pre-service language teaching," *Education Sciences*, vol. 13, no. 12, p. 1238, 2023. https://doi.org/10.3390/educsci13121238

[18] O. B. Sasere and S. D. Makhasane, "Adult learning theory tenets: A panacea to ICT skills gaps among educators in South Africa," *Journal of Education (University of KwaZulu-Natal)*, no. 92, pp. 58-75, 2023. https://doi.org/10.17159/2520-9868/i92a04

[19] J.-A. Marín-Marín, J. López-Belmonte, S. Pozo-Sánchez, and A.-J. Moreno-Guerrero, "Attitudes towards the development of good practices with augmented reality in secondary education teachers in Spain," *Technology, Knowledge and Learning*, vol. 28, no. 4, pp. 1443-1459, 2023. https://doi.org/10.1007/s10758-023-09671-9

[20] J. Mateus, P. Andrada, C. González-Cabrera, and C. Ugalde, "Teachers' perspectives for a critical agenda in media education post COVID-19. A comparative study in Latin America," *Comunicar*, vol. 30, no. 70, pp. 9-19, 2022. https://doi.org/10.3916/c70-2022-01

[21] N. Gómez-Fernández and M. Mediavilla, "Factors influencing teachers' use of ICT in class: Evidence from a multilevel logistic model," *Mathematics*, vol. 10, no. 5, p. 799, 2022. https://doi.org/10.3390/math10050799

[22] V. D. J. Mendoza, M. Navarro Cejas, M. F. Cejas Martínez, P. G. V. N. Vinueza Naranjo, and V. Vega Falcón, "Digital andragogical competences of Ecuadorian higher education teachers during the COVID-19 pandemic," *European Journal of Educational Research*, 2021. https://doi.org/10.12973/eu-jer.10.3.1341

[23] Y. M. Paje, D. V. Rogayan Jr, and M. J. P. Dantic, "Teachers' utilization of computer-based technology in science instruction," *International Journal of Technology in Education and Science*, vol. 5, no. 3, pp. 427-446, 2021. https://doi.org/10.46328/ijtes.261

[24] G. N. Hafıfah and G. H. Sulıstyo, "Teachers'ict literacy and ict integration in elt in the Indonesian higher education setting," *Turkish Online Journal of Distance Education*, vol. 21, no. 3, pp. 186-198, 2020. https://doi.org/10.17718/tojde.762050

[25] A. E. Garzón, T. S. Martínez, J. L. Ortega Martin, J. A. Marin Marin, and G. Gomez Garcia, "Teacher training in lifelong learning—The importance of digital competence in the encouragement of teaching innovation," *Sustainability*, vol. 12, no. 7, p. 2852, 2020. https://doi.org/10.3390/su12072852

[26] J. M. Fernández-Batanero, B. Sañudo, M. Montenegro-Rueda, and I. García-Martínez, "Physical education teachers and their ICT training applied to students with disabilities. The case of Spain," *Sustainability*, vol. 11, no. 9, p. 2559, 2019. https://doi.org/10.3390/su11092559

[27] M. M. Rueda and J. F. Cerero, "Main barriers to ICT teacher training and disability," *Research in Social Sciences and Technology*, vol. 4, no. 2, pp. 96-114, 2019. https://doi.org/10.46303/ressat.04.02.7

[28] A. A. Syahid and D. Nugraha, "Development of a training curriculum structure to improve ICT competencies of teachers in primary schools," in *Elementary School Forum (Mimbar Sekolah Dasar)*, 2019, vol. 6, no. 1, pp. 21-31.

[29] J. Gil-Flores, J. Rodríguez-Santero, and J.-J. Torres-Gordillo, "Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure," *Computers in Human Behavior*, vol. 68, pp. 441-449, 2017. https://doi.org/10.1016/j.chb.2016.11.057

[30] S. Kazan and B. EL-Daou, "The relationship between teachers' self-efficacy, attitudes towards ICT usefulness and students' science performance in the Lebanese inclusive schools 2015," *World Journal on Educational Technology: Current Issues*, vol. 8, no. 3, pp. 277-293, 2016. https://doi.org/10.18844/wjet.v8i3.550

[31] C. Akarawang, P. Kidrakran, and P. Nuangchalerm, "Enhancing ICT competency for teachers in the Thailand basic education system," *International Education Studies*, vol. 8, no. 6, pp. 1-8, 2015. https://doi.org/10.5539/ies.v8n6p1

[32] M. A. Montoro, F. J. Hinojo-Lucena, and F. R. Sánchez, "A study on ICT training among faculty members of Spanish faculties of education," *The New Educational Review*, vol. 42, pp. 27-39, 2015. https://doi.org/10.15804/tner.2015.42.4.02