Impact of Integrating Educational Technology on Teacher Preparedness: A Systematic Review and Meta-Analysis

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Abstract

The primary objectives of this review are (1) to provide an overview of the impact of integrating Educational Technology on Teacher Preparedness, (2) to integrate technology into teaching and learning, and (3) to present teachers' thoughts about technology integration and barriers to integrating technology in education. The systematic literature searches of English language articles were conducted in November 2023 in the Scopus database, yielding 13 studies that met the inclusion criteria and represented six countries. Data analysis resulted in ways for applying the technological pedagogical content knowledge (TPACK) framework within teacher preparation programs. In addition to Integrating technology into teaching and learning. Nevertheless, preservice teachers' perceptions regarding technology integration should be considered. The results have implications for integrating technology effectively into the curriculum, resulting in better use of technology for student learning. Limitations of the study are discussed.

Keywords: *Teacher Training, Digital Learning, Technological Pedagogical, Digital Competencies, Teacher Preparedness*

INTRODUCTION

Teachers' effectiveness goes beyond subject knowledge, requiring a blend of pedagogical expertise and proficiency in integrating technology (Jackson et al., 2014; Kunter et al., 2013). In the digital age, educators face the challenge of incorporating digital media seamlessly into their teaching(Chai et al., 2013). The Technological Pedagogical Content Knowledge (TPACK) framework is a widely used model emphasizing the integration of technological, pedagogical, and content knowledge for effective teaching (Mishra & Koehler, 2006). Research and teacher education programs aim to enhance teachers' proficiency in utilizing digital media (Graham et al., 2009; ISTE, 2008). Understanding and applying the TPACK framework is crucial for educators navigating the evolving educational landscape.

New content standards require that teachers support student mastery of digital tools and Internet research (Common Core State Standards, 2010) These standards apply to all students, including those with historically poorer performance in state assessments, such as students with learning disabilities (SWLDs) and English language learners (National Center for Education Statistics [NCES],2015). Efforts to improve science and mathematics education in Tanzania involve the integration of ICT, which was initiated in collaboration with SIDA and IICD in 2002 (Hare, 2007; Tilya, 2008). The Ministry of Education endorsed ICT as a subject and a pedagogical tool for teaching various subjects (URT, 2007). Despite these initiatives, studies indicate low and inadequate ICT utilization by teachers due to limited knowledge and skills in technology integration (Hare, 2007; Swarts & Wachira, 2010; Tilya, 2008). Computers in Tanzanian schools are often used for administrative purposes rather than instructional delivery (Swarts & Wachira, 2010).

In the US, the Education Technology Plan (U.S. Department of Education, 2017) stated that technology has rapidly changed in access to technology in the classroom, the variety and the cost of technology, the emphasis on data security, the importance given to technology in education by the leaders, and the significance of teacher learning to integrate technology into education.

The discourse surrounding technology in education is characterized by two primary perspectives: technology integration and technology transformation, delineated by Reigeluth & Joseph(2002) Technology integration

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involves employing technology to support teaching methods, while technology transformation denotes fundamental changes in instructional approaches.

Ertmer (2005) aligns technology integration closely with technology transformation, emphasizing the imperative to achieve sophisticated and authentic educational goals. Coleman (2015) defines technology integration as the use of technology to supplement and drive instruction, while Rehmat and Bailey (2014) associate it with the appropriate selection and use of technology within lessons to enhance student learning, guided by the TPACK model.

Teachers consistently underscore the positive impact of technology on student engagement and achievement (Kay et al., 2009; Saine, 2012). Technology is also recognized for enhancing the learning experience for students with special needs (Pennington, 2010). Studies indicate technology fosters collaboration and engagement (Scalise, 2016; Shaltry et al., 2013).

Barriers to technology integration, as categorized by Ertmer (1999), include first-order (external) and second-order (internal) barriers. External barriers encompass access to technology, time constraints, lack of support, and inadequacies in Professional Development, while internal barriers involve teacher confidence and beliefs in the efficacy of the technology.

Professional Development emerges as a critical factor in overcoming barriers, with studies demonstrating a positive influence on teachers' technology use (Bhasin, 2012; Blocher et al., 2011; Hendawi et al., 2024; Kopcha, 2012; Scott & Mouza, 2007). However, Hur et al.(2016) argue that professional Development may not significantly impact technology use but can shape teachers' perceptions of technology integration.

Teacher beliefs and confidence are crucial in overcoming external barriers to technology integration (Ertmer et al., 2012; Mosleh et al., 2023; Qadhi et al., 2023). Studies by Wong (2015) and Miranda & Russell (2012) highlight that teachers' belief in the benefits of technology significantly influences its utilization. However, insufficient knowledge and self-efficacy hinder effective technology integration despite teachers' willingness (Aslan & Zhu, 2015; Kimmons & Hall, 2016; Moore-Hayes, 2011). Kim et al. (2013) emphasize the reciprocal relationship between teachers' technology integration practices and their beliefs about effective teaching methods. Internal barriers such as discomfort with technology, resistance to change, and reliance on traditional teaching styles also impede successful technology integration (Keengwe et al., 2008; Wood et al., 2008).

Teachers' pedagogical beliefs are considered to play a vital role in achieving this objective(Chaaban et al., 2023; Ertmer et al., 2012; Tondeur et al., 2008, 2017). Ertmer (2005) even argues that teachers' pedagogical beliefs are "the final frontier in our quest for technology integration." Inspired by the work of Pajares (1992).

This so-called "whole child" approach to teaching (Lasky, 2005) is also emerging in technology integration issues. Questions that are associated with the impact of digital technologies on children's and adolescents' physical and psychological well-being are a matter of widespread scientific and public debate (Orben & Przybylski, 2019; Palaiologou, 2017), For over 20 years, effective technology integration has been a focus for schools due to solid evidence that it can support learning (Bransford et al., 2000; Hickey et al., 2001), increase academic performance (Hannafin & Foshay, 2008), and achieve valuable 21st-century learning outcomes (Bereiter & Scardamalia, 2006; Kozma, 2003).

The number one barrier to technology integration in schools has consistently been teacher beliefs (Kennedy, 2016), and this continues today (Wilichowski & Cobo, 2021).

Considering the increasing technological skills expected of preservice teachers to enter their first classrooms, many are only partially adept at integrating technology for instructional purposes (Ciampa, 2017; Walsh & Farren, 2018). Barriers to technology implementation facing teacher educators include a lack of knowledge and training, familiarity, and access to technology (Kalonde & Mousa, 2016). Beyond access, teacher educators claim the need to engage students in hands-on technology experiences that include exploration and experimentation (Vasinda et al., 2017).

In this meta-review, we aim to evaluate the impact of Educational Technology on Teacher Preparedness and delve deeper into integrating technology into teaching. It also seeks to understand how preservice teachers

perceive technology integration in education. This research aims to provide valuable insights into effectively incorporating technology in education. To achieve this objective, we will conduct a comprehensive meta-review of research integrating technology and Teacher preparation. We will address the following research questions (RQ):

RQ1. How does integrating Educational Technology impact Teacher Preparedness (countries represented, methods used, and topics discussed)?

RQ2. How does technology contribute to the Professional Development of preservice teachers?

RQ3. What perceptions and beliefs do teachers hold regarding integrating technology in education?

METHODOLOGY

This meta-synthesis adopts an interpretive methodology, diverging from an aggregative approach, to consolidate insights derived from qualitative, quantitative, and mixed-methods studies exploring congruent or closely interrelated topics. Employing a systematic framework, this study undertakes a rigorous process to systematically collect and analyze a heterogeneous selection of publications elucidating diverse facets of technology integration within education.

The systematic literature searches of English language articles were conducted in November 2023 in the Scopus database. The search parameters encompassed four delineated categories. First, words covering the context: ("teacher education" OR "Teacher preparation" OR "teacher training"). Second, we include the term (technology). Third, we included ("integrating Technology") and fourth, our searches were restricted to journal articles and conference papers. The time limit is between 2013 and 2023. We have only included open-access (Green, Bronze, Gold) research published in English.

Study Identification and Data Extraction

The electronic inquiry yielded a total of 113 articles and conference papers. One hundred were excluded as they contradicted at least one of the predetermined inclusion criteria. The authors meticulously examined the remaining 21 studies. Subsequently, thirteen studies were deemed suitable for inclusion in this review. See **Fig. 1**

Inclusion criteria were defined, specifying that the study should report on data about teacher preparedness and integrating technology in education. Conversely, exclusion criteria pertained to studies addressing information and communication technology (ICT) in education and utilizing technology as a teaching strategy without emphasizing teachers' preparedness. Any disparities in study inclusion were resolved through collaborative discussion among the authors.
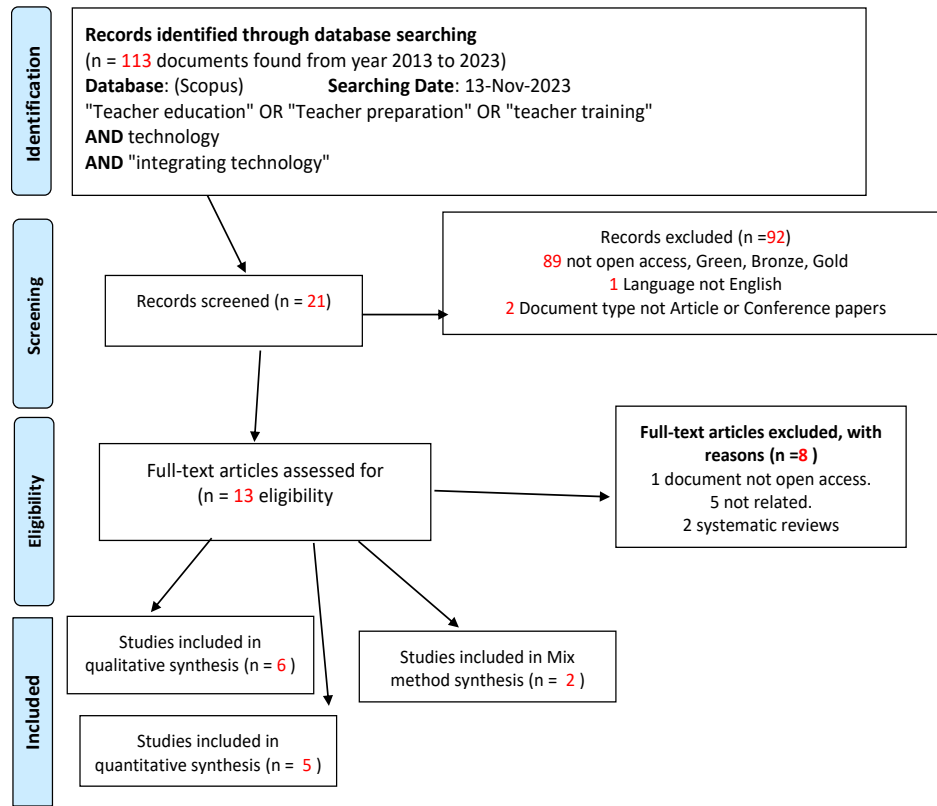
Fig.1 PRISMA Flow chart (search results, screening, and inclusion-exclusion).

Analysis

We thoroughly analyzed different studies to explore how educational technology affects teacher preparedness. Our approach involved extracting information about each study's research questions, theoretical approaches, samples, and results. We carefully re-read each study and extracted detailed information to capture its findings' intricacies and details. The studies used various research methods, including qualitative, quantitative, and mixed methods, which we combined to provide a comprehensive analysis with detailed information and broad trends. We identified three contexts within the material, which was an important step as they provided a framework for interpreting the various findings (see Table 1). These contexts revolve around the impact of technology on teacher readiness, the use of technology in preservice teacher professional development, and teachers' beliefs about technology integration.

Table.1

Context	Descriptions	Studies (First Author and Year)
Impact of integrating educational technology on teacher preparedness	Teachers with prior technology experiences can better integrate technology effectively into the curriculum, resulting in better use of technology for learning by students. Teachers should have the technological literacy skills to enhance students' writing in the digital age.	(Abubakir & Alshaboul, 2023; Baier & Kunter, 2020; Demeshkant, 2020; Eutsler, 2022; Knox et al., 2016; Niess, 2017)
Use of Technology in the professional development of preservice teachers	Teachers need access to the right technology tools and engage in pedagogically sound, high-quality professional Development. Teachers' professional knowledge and the instructional quality they provide are essential predictors of student achievement.	(Environmental and Public Health, 2023; Howell et al., 2021; Kafyulilo et al., 2015; Kim, n.d.; Wu et al., 2023)

Teachers' perceptions and beliefs about technology integration in education	Current perceptions of preservice teachers about technology integration, their ideas about barriers to technology integration in education, and gaining insight about technology integration in education to improve the current practices.	(Dinc, 2019; Mertala, 2019)

RESULTS

How does integrating Educational Technology impact Teacher Preparedness (countries represented, methods used, and topics discussed)?

The 13 included studies were carried out in 6 countries. Most studies are from the United States (8) and Europe (3). Only one study was carried out in Asia and one in South Africa. 6 studies were conducted on in-service teachers, five on pre-service teachers, one on pre-service and in-service teachers, and one on future academic teachers (PhD students).

Most studies are qualitative (6), five are quantitative, and two were carried out using quantitative and qualitative methods.

The 13 studies included in our review were conducted in various settings and for diverse purposes. To provide a structured overview, we categorized them into three different contexts or situations (table 1). The studies are grouped based on the identified contexts, and below, we provide a summary of the topics discussed.

The integration of educational technology significantly influences teacher preparedness, as revealed through a systematic review encompassing 13 studies across six countries. These studies, employing a mix of qualitative, quantitative, and mixed methodologies, focus on a diverse group of educators, including in-service and pre-service teachers as well as future academic teachers. They illustrate the nuanced impacts of technology in teaching contexts, emphasizing enhanced educational outcomes, engagement, and pedagogical strategies, alongside challenges like access, professional development, and perceptions of technology's role in education. This comprehensive examination underscores the critical role of technology in evolving educational paradigms.

Development of Technological Pedagogical Content Knowledge (TPACK)

Four of the 13 studies explored the importance of having teachers equipped with the required technological literacy skills to enhance students' learning (Abubakir & Alshaboul, 2023; Eutsler, 2022; Knox et al., 2016; Niess, 2017).

The four studies highlighting the development of Technological Pedagogical Content Knowledge (TPACK) provide a comprehensive look into the critical role of technology in modern education. They underscore the necessity for teachers to possess a robust set of technological literacy skills, which, when effectively integrated with pedagogical and content knowledge, substantially enhance the learning process. This integration is essential for creating an educational environment that is not only engaging but also deeply enriching, enabling students to achieve higher levels of understanding and application. The emphasis on TPACK within these studies reflects a growing recognition of the need to prepare educators for the complexities of teaching in the digital age, highlighting the transformative potential of technology in education.

Professional Development Model (Knox et al., 2016)

The study by Knox et al. (2016) evaluated a face-to-face professional development model designed to integrate technology into teaching. This model, tested in a real-world setting, aimed to equip teachers with effective strategies for using the SOAR Student Toolkit, a resource designed to enhance online academic research skills among students, including those with learning disabilities. The emphasis was on practical implementation, allowing teachers to directly apply what they learned in their classrooms, thereby bridging the gap between professional development and classroom practice. This approach underscores the importance of hands-on, practical training in effective technology integration within educational settings.

TPACK Mastery in Qatar (Abubakar & Alshaboul, 2023)

The study conducted by Abubakar & Alshaboul (2023) delves into the proficiency of preparatory English as a Foreign Language (EFL) teachers in Qatar regarding the Technological Pedagogical Content Knowledge (TPACK) framework, particularly within the context of writing classes. Through a descriptive research design, the study engaged 182 in-service teachers who participated by completing a self-reported TPACK survey. This approach aimed to gather insights into the current state of TPACK mastery among EFL teachers, identifying both strengths and areas for development. The focus on EFL teachers in Qatar contributes to a deeper understanding of how educators in diverse linguistic and cultural settings are adopting and integrating technology into their pedagogy. The findings from this study are crucial for informing future professional development programs, aiming to enhance the effective integration of technology in teaching practices, particularly in the realm of language education.

Teacher Education Program (Eutsler, 2022)

The study (Eutsler, 2022) unfolded within a teacher education program at a large public university in the southwestern U.S. Enrolling 38 preservice teachers in an early literacy methods course, the research explored the demographic and technological landscape of these future educators, emphasizing the need for technological preparation in teacher education(Chaaban et al., 2021; Qadhi, 2023) .

Case Study on Mathematics Teaching (Niess, 2017)

The case study by Margaret L. Niess (2017) is descriptive. It examines how the practical teaching experiences blended with teacher-participants' inquiries as a community of learners influenced their rethinking, relearning, and redefining mathematics teaching with multiple technologies.

The study involved nine K-12 in-service teachers who agreed to participate in the study as they examined their teaching of mathematics with technology in their classrooms. All had taught for over three years, mostly between 4 and 8.

Knowledge Test Development (Baier & Kunter, 2020)

The study (Baier & Kunter, 2020) explored the personal digital competence of PhD students as future academic teachers. Through a large-scale longitudinal qualitative survey, the research investigated the digital competence levels of 120 participants, using a questionnaire based on the European Competency Framework for Digital Competence of Educators. Developed and validated a knowledge test to measure (pre-service) teachers' technological pedagogical knowledge (TPK). TPK to help close this research gap. In this study, four researchers were invited to participate via e-mail. Upon agreement, they received an interactive text document with the test items, the coding scheme, and scales to rate both items and the coding scheme. The researchers rated the test items according to their clarity, their relevance for teaching, and most importantly, their construct fit on a four-point Likert scale, ranging from 1 ("disagree") to 4 ("agree"). They also rated the correctness of the proposed answers in the coding scheme and whether they thought any answer categories were missing.

Pre- and in-service teachers answered an online questionnaire. They first responded to each test item and then rated each item in terms of its clarity and relevance for teaching on a six-point Likert scale, ranging from 1 ("fully disagree") to 6 ("fully agree"). They were also allowed to comment on each item.

There is an attempt to study the personal level of digital competence of PhD students as future academic teachers (Demeshkant, 2020). The study (n=120) piloted large-scale longitudinal qualitative teachers' surveys between 2017 and 2020. The first part of the research started in 2017 to attempt to recognize the personal level of digital competence of PhD students as future academic teachers. The study was conducted during 2017-2018 at the Wroclaw University of Environmental and Life Sciences. A special questionnaire based on the European Competency Framework for the Digital Competence of Educators was used to study the levels of digital competence.

Integrating technology into teaching and learning.

The topics discussed in these studies are pretty diverse.

Developing Technological Pedagogical Content Knowledge (TPACK) in Pre-Service Teachers (Kafyulilo et al., 2015)

In this study by (Kafyulilo et al., 2015), A total of 22 pre-service science and mathematics teachers in the Bachelor of Education in Science [B. Ed (science)] from developing technological pedagogical content knowledge participated in the study. Also, the B.Ed (science) program included students who specialized in mathematics, chemistry, physics, and biology and attended a course on ICT for science and mathematics teachers, which were the focus subjects in this study (i.e., science, mathematics, and ICT). Three kinds of data collection instruments were used in this study: the TPACK survey, an observation checklist, and a reflection questionnaire.

Multimedia Teaching Applications in Music Performance Education (Environmental & Public Health, 2023)

The study by (Environmental & Public Health, 2023) Explored the laws and experiences of music performance teachers' multimedia teaching applications (an essential part of modern information technology) under the framework of subject-teaching knowledge integrating technology. The research methods used were: 1. Classroom observation method. By observing the excellent courses and daily 2. Statistical Analysis of Data. Implement the measurement tool to obtain the relevant Research Objects.

Integrating Digital and Social Processes in Writing Instruction (Howell et al., 2021)

The study conducted by (Howell et al., 2021) focused on a professional development model that helps teachers engage students in writing as both a digital process and a social process. The study involved upper elementary school teachers and investigated how it was integrated into teachers' instruction to improve their ability to make writing a more digital, participatory process. The data was collected in three phases: assessment of the teachers' needs regarding PD, PD to begin to meet those needs with a four-day PDI, and further implementation of the PD in which the PD providers collaborated with teachers.

Impact of Gamified Online Course on Pre-Service Teachers (Wu et al., 2023)

The study (Wu et al., 2023) explores the impact of a gamified online course on pre-service teachers' confidence, intention, and motivation in integrating technology into teaching. This study examined the effects of a gamified technology course on pre-service teachers' confidence, intention, and motivation in incorporating technology into teaching. A sample of pre-service teachers (N = 84) at a Midwestern university in the United States in the academic year of 2021–22 was surveyed.

Perceived Impact of a Thinking Tool and Ideation Process on Technology Integration (Kim, n.d.)

The study by (Kim, n.d.) explored the perceived impact of a designed Thinking Tool and ideation process instead of practicum experiences, revealing little to no modeling of student use of technology for in-process learning. Grappling with patterns in candidate gathered observational data (121 pre-service teachers over seven separate technology-focused courses). This study explored the perceived impact of a designed Thinking Tool and ideation process instead of practicum experiences, revealing little to no modeling of student use of technology for in-process learning. Data was collected from the Thinking Tool and candidate reflections.

Preservice teachers' thoughts about technology integration and barriers to integrating technology in education.

Both studies (Dinc, 2019; Mertala, 2019) revealed that preservice teachers have different views regarding technology integration in education, and they expected that many challenges are waiting for them in terms of technology integration when they begin teaching.

Preservice Teachers' Perspectives and Barriers to Technology Integration

The study (Dinc, 2019) examined the thoughts of preservice teachers about technology integration and collected their ideas about possible barriers to technology integration in education. This study was carried out with 76 volunteer preservice teachers at a university in the northeast part of the US. The criterion sampling method, one of the purposive sampling methods, was used to identify the participants. The criterion sampling method follows predetermined criteria for choosing cases in the study (Patton, 1990). Considering the purpose of the research, potential participants should have been preservice teachers and taken a course about technology integration. Therefore, 76 preservice teachers who took the "Integrating Technology in Education" course during their Elementary Teacher Education program participated in the study.

Early Childhood Teachers' Perspectives on Technology Integration

The study (Mertala, 2019) examined how early childhood teachers' beliefs about technology integration reflect the threefold task of education, socialization, and care. This study has synthesized 35 qualitative empirical research studies via meta-ethnography. The focus is on early childhood education.

DISCUSSION

The studies included in this review have provided insights into applying the TPACK framework in various ways within teacher preparation programs.

Teachers who were trained with the face-to-face professional development model successfully implemented the curriculum with students with learning disabilities SWLDs as well as general education students, as demonstrated by similar knowledge gains in both groups (Knox et al., 2016). To enhance the technological literacy skills of teachers, it is crucial to explore and compare various training methods. This will help identify the most effective ways to improve teachers' abilities and competencies. According to the study, face-to-face professional development can have a positive impact on general education as well as students with learning disabilities. To ensure long-term success and inclusivity in diverse educational settings, future research and practice should concentrate on refining and expanding such models.

Male teachers showed a greater level of technological knowledge than female teachers. Teachers with 1 to 5 years of experience scored at the highest level of technological expertise, and teachers who received professional Development outperformed their peers in TPACK. The study findings provide insights to educators and policymakers concerned about teachers' education and professional development; teachers must be equipped with the required technological literacy skills to enhance student's writing in the digital age (Abubakar & Alshaboul, 2023). To address the differences in technology skills among teachers, it is important to focus on targeted interventions that address the gender and experience gaps. One way to do this is by developing strategies that empower female teachers and support the professional development of educators beyond their first 5 years of experience.

The pedagogical knowledge construct of TPACK and a scaffolded use of the gradual release of responsibility framework helped preservice teachers design literacy instruction with the iPad. TPACK framework is a well-known technology integration framework intended to help teachers think about integrating new technologies. The TPACK framework has been applied in vario(Eutsler, 2022). The success of the TPACK framework in guiding preservice teachers to design literacy instruction with iPads highlights the need for its continued integration into teacher education programs. Future research should investigate effective strategies for implementing TPACK across different subject areas and contexts.

As teacher education programs expand to incorporate and take advantage of online learning contexts, teacher educators need to understand how teachers incorporate their thinking about teaching mathematics with technologies into their classroom practice –their TPACK-of-practice (6)

A knowledge test can validly measure technological pedagogical knowledge (TPK). The test can assess teachers' specialized pedagogical understanding, an essential aspect of teacher preparedness for integrating educational

technology (Baier & Kunter, 2020). Developing dependable assessment tools for measuring Technological Pedagogical Knowledge (TPK) is essential. Further research should refine and expand these tests to cover a broader range of technological and pedagogical competencies.

The studies also discussed a gap between the digital demands that newly qualified teachers meet in their profession and the training in using instructional technology provided during teacher education. There is a need for teacher training programs to move beyond basic digital skills and the use of ICT as a tool to find ways of building the interpretive and creative potential of ICT into teacher training (Demeshkant, 2020). Teacher training programs need to be evaluated and revised to bridge the gap between digital requirements for new teachers and the training they receive. Research should focus on innovative ways to incorporate the interpretive and creative potential of ICT into teacher training programs.

The study results show different levels of digital competence depending on the student's field of study and specialty. Ph.D. students of engineering specializations demonstrated the highest technological scores. The preliminary study results indicate the need to improve Ph.D. training programs, including developing students' skills to better use digital technology for teaching and learning (Demeshkant, 2020b; Romanowski & Qadhi, 2022). Future research should explore customized methods for improving digital skills in PhD programs, based on students' specific academic fields.

Pre-service teachers who participated in the professional development designed in the study by (Al Qadhi et al., 2022; Floyd et al., 2023; Kafyulilo et al., 2015) had sufficient knowledge of pedagogy, content, and pedagogical content knowledge but limited knowledge of technology-related components of TPACK as revealed in self-perception and observation data, training, microteaching, reflection, and lesson design were perceived to have almost equal impact on the Development of pre-service teachers' knowledge and skills of integrating technology in science and mathematics teaching. To prepare pre-service teachers for their future careers, it is crucial to balance the different components of TPACK related to technology. This requires exploring effective methods for integrating technology into pedagogy and content knowledge, providing a comprehensive preparation for future educators. Further research is necessary to investigate and develop such methods.

The music performance teaching. Using multimedia, teachers can integrate beautiful songs, dynamic pictures, and rich emotions. From this advantage, the teaching design based on multimedia technology should combine the cognitive laws of college students, the different characteristics of multimedia technology, and the subject characteristics of music performance to improve and optimize the teaching content (Environmental & Public Health, 2023). It is important to investigate how multimedia technology can be optimally integrated into different teaching contexts, considering cognitive principles, technological features, and subject-specific nuances. This can contribute to more effective and engaging teaching strategies.

The successes included teachers' implementation of Personal Development and their reflection on improving in both incorporating digital tools into their writing curriculum and having more confidence in teaching writing, digital writing, and student collaboration with writing(Howell et al., 2021). It is important to explore effective strategies that can assist teachers in integrating digital tools into the writing curriculum. This can be achieved through targeted professional development programs.

For new teachers entering the profession, the process suggests that imagining how technology can transform instruction without it being consistently modeled involves recognizing when practices are replicated overlayed with technology and being willing to explore design opportunities. Hence, students use tools to construct their learning (Kim, n.d.). Research should emphasize the importance of technology integration and explore innovative design opportunities to enhance student learning for new teachers.

To prepare a proper technology plan and professional development opportunities, preservice teachers' perceptions regarding technology integration should be considered. The preservice teachers identified many external barriers, and their statements showed that internal obstacles are also negatively effective in technology integration. Unlike the other studies in the literature, preservice teachers stated in this research that parents and security could be barriers to technology integration (Dinc, 2019). Future research should explore preservice

teachers' perceptions of technology integration. Program development must address internal and external barriers, such as parental concerns and security.

The lack of initial and continuing training was addressed in many of the reviewed studies, and training also appeared to concentrate solely on using technology as a tool for teaching curricular subjects. Such an approach, however, fails to pay respect to aspects of socialization and care and, thus, is based on a one-sided and restricted understanding of early childhood education(Mertala, 2019). Future research and practice should prioritize a more comprehensive understanding of technology integration in early childhood education. This should consider the socialization and care aspects crucial for the holistic development of young learners.

The reviewed studies provide valuable insights for effectively integrating educational technology into teacher preparedness programs. These studies suggest various training methods, including gender-specific training, which can help to reduce gender gaps and better incorporate the TPACK (Technological Pedagogical Content Knowledge) framework into teacher training programs. A crucial aspect of this integration process is the development of reliable assessments that can accurately measureTechnological Pedagogical Knowledge (TPK). Moreover, it's essential to improve teacher training programs and customize digital skills in Ph.D. programs to enhance the quality of education.

In addition, it's important to prioritize technology integration for new teachers and understand pre-service teachers' views on technology integration. This will help to ensure that teacher training programs better align with future teachers' needs and expectations. Researchers must also prioritize a comprehensive approach to early childhood education that considers not only academic learning but also socialization and care aspects. Developing a more holistic approach to education can better suit the needs of students and teachers today.

SUMMARY OF MAIN FINDINGS

Teachers require professional Development that increases knowledge and confidence in using technology, incorporates practice with the technology tools, and offers guidance for creating or joining learning communities.

Well-designed professional Development is significant for enhancing learning for students with learning disabilities.

A performance-based knowledge test will help explore the importance of technological knowledge areas defined in the TPACK framework for teachers' instructional quality and their student's achievements.

Using ICT as a tool to build ICT's interpretive and creative potential into teacher training.

Teachers' implementation of the PD and their reflection on improving in both incorporating digital tools into their writing curriculum and having more confidence in teaching writing, digital writing, and student collaboration with writing.

Gamified courses significantly and positively influenced pre-service teachers' confidence in using technology in education, intention to adopt gamification, and motivation to explore more emerging technologies for teaching.

Preservice teachers identified internal and external barriers. Internal barriers are gathered mainly under these two: lack of knowledge and ability. In contrast, there are external obstacles in lack of funding/budget, parents, and security.

Education, socialization, and care all have a meaningful role in teachers' beliefs about technology use in early childhood education.

Limitations

The limitations of these studies are multifaceted. In the investigation of face-to-face professional Development, valuable insights into teachers' and students' perceptions are marred by small sample sizes, limiting generalizability, and potential bias introduced by individual teacher performance. While suitable initially, the quasi-experimental design lacks control over confounding factors, compromising internal and external validity.

Similarly, a study on a time-consuming test format grapples with incomplete responses and technology-related item obsolescence, suggesting modifications but emphasizing the preliminary nature of validity evidence and the need for further validation efforts. Another study highlights limitations from tiny sample sizes and self-developed measures, necessitating validation in additional studies and a more comprehensive approach to measure intention and motivation to use technology. Lastly, reliance on self-reported surveys in assessing Technological Pedagogical Content Knowledge introduces potential bias, though efforts were made to enhance reliability and validity through rigorous statistical analysis (Knox et al., 2016; Baier & Kunter, 2020; Wu et al., 2023; Abubakir & Alshaboul, 2023).

CONCLUSION

In conclusion, this systematic review and meta-analysis have illuminated the multifaceted impact of educational technology on teacher preparedness. Our investigation across diverse educational settings and populations has underscored the pivotal role of technological pedagogical content knowledge (TPACK) in enhancing teacher efficacy and student learning outcomes. The findings reveal a consensus on the necessity for teachers to be adept in integrating technology into their pedagogy, not only to meet the evolving educational standards but to foster an engaging and inclusive learning environment. While challenges such as access to resources, professional development, and attitudinal barriers towards technology use persist, the overall evidence supports a positive trajectory towards technology-enhanced teaching. This study contributes to the body of knowledge by providing a comprehensive overview of current practices and perceptions, thereby guiding future research, policy formulation, and practice in educational technology integration. As we move forward, it is imperative for stakeholders in the educational ecosystem to collaborate in addressing these challenges, ensuring that teachers are well-prepared to navigate and thrive in the digital age of teaching and learning.

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