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A Systematic Comprehensive Review: Role of Instructional Technology as a Mediator in Teacher Competence

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ABSTRACT

Expert scholars have recognized the urgent need to investigate the impact of instructional technology on teacher competence in response to the evolving landscape of education. This systematic comprehensive review (SLR) takes up the challenge by thoroughly examining the intricate relationship between instructional technology and teacher competence. The introduction underscores the growing significance of instructional technology in modern education, while the problem statement emphasizes the critical need to understand how instructional technology acts as a mediator in shaping teacher competence. The study rigorously employs the PRISMA guidelines for its systematic review and conducts an exhaustive examination of research findings sourced from Scopus and Web of Science (WoS), with n=33 articles found in the last step of the review process. In response to this inquiry, expert scholarly decision-making has culminated in the development of three fundamental themes: Technology in Education and Pedagogy, Teacher Training and Professional Development, and Learning Outcomes and Educational Research. In conclusion, this SLR offers invaluable insights into the multifaceted dynamics between instructional technology and teacher competence, addressing a pressing concern in education. Educators, policymakers, and researchers will find this study a valuable resource for enhancing teacher competence through the integration of instructional technology.

1. Introduction

In today's rapidly evolving educational landscape, the integration of instructional technology has emerged as a pivotal component in enhancing teaching and learning experiences[1,2]. The dynamic synergy between educators and technology holds immense promise for improving teacher competence and, by extension, the quality of education[3,4]. As educators strive to adapt to ever-changing pedagogical demands and technological advancements, understanding the intricate relationship between instructional technology and teacher competence becomes paramount [5,6].

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This systematic comprehensive review embarks on a journey to unravel the multifaceted role of instructional technology as a mediator in shaping teacher competence. Teacher competence, encompassing a spectrum of skills, knowledge, and attitudes, forms the bedrock of effective education[7,8]. Instructional technology, with its diverse arsenal of digital tools, platforms, and strategies, serves as a transformative force capable of amplifying teacher efficacy, pedagogical innovation, and student engagement [9]. By delving into the existing body of literature, this review endeavors to provide a comprehensive synthesis of empirical findings, theoretical frameworks, and practical insights pertaining to the intersection of instructional technology and teacher competence. Through a meticulous analysis of research studies, we aim to elucidate the mechanisms through which instructional technology influences and mediates the development of teacher competence.
Moreover, this review will identify gaps in the current knowledge landscape, highlighting areas requiring further investigation and exploration. It is our fervent hope that this systematic exploration will not only contribute to the academic discourse but also offer guidance to educators, policymakers, and practitioners as they navigate the dynamic terrain of educational technology and its transformative potential in fostering [10].

2. Literature Review

In 2023, Evens and his team explored the use of more accessible and budget-friendly 360° videos for education, highlighting their potential to create immersive learning experiences. They reviewed 26 studies and found that these videos were often used in higher education, showcasing environments, situations, or demonstrations, and they typically lasted 5 to 15 minutes. Their research showed that 360° videos had positive effects on learning, improving content understanding, attitudes, and the sense of immersion. Based on their findings, they provided guidelines for designing effective educational 360° videos, making them a practical tool for educators and learners seeking engaging learning experiences [11].

Recent research examined data collected from 357 undergraduate and graduate teacher education students to evaluate the effectiveness of the Synthesis of Qualitative Data (SQD) instrument in measuring six critical teaching strategies (role models, reflection, collaboration, feedback, instructional design, and authentic experiences) essential for preparing future teachers to integrate technology into their teaching. The study utilized statistical techniques like factor analysis, multidimensional scaling, and analysis of variance to assess the instrument's reliability and validity, resulting in the creation of six distinct four-item scales. The findings indicated that all scales performed well as independent measures, suggesting that future studies could use smaller subsets of the 24-item instrument. The study also suggested directions for future research and practical implications for teacher preparation programs [12].

Recent research emphasizes educators' reliance on professional development to enhance their teaching. Instructional coaching, including practices like classroom observation and goal setting, as well as strategies like co-teaching, has been shown to bring significant improvements. This study aimed to assess the impact of a web-based coaching tool on classroom practices and student outcomes in prekindergarten. Researchers conducted a trial, comparing traditional coaching to the app-based approach [13]. Classroom observation data showed no significant differences in teacher practices, and student achievement remained unchanged [14]. However, qualitative data suggested that the app users employed effective coaching strategies. The study's limitations may be due to statistical power and disruptions caused by the pandemic. Further research on educational technologies supporting professional development is needed [15].

According to a study by Fütterer *et al.,* in 2023, effective integration of technology in classrooms requires teachers to be well-prepared and motivated. Professional development (PD) plays a crucial role in equipping in-service teachers with the skills to use technology effectively. While previous research has focused on the link between teachers' motivation, technology use, and PD participation, this study aimed to explore additional predictors like technology-related knowledge and personality traits, particularly conscientiousness. The study analyzed data from 321 in-service teachers and found that teachers' perception of the usefulness of technology in the classroom was a stronger predictor of their intention to participate in technology-related PD than their technology-related knowledge or conscientiousness. This suggests that highlighting the practical benefits of technology in education remains important to encourage teacher participation in PD, contrary to previous assumptions [16].

In a recent study conducted by Kormas and Wisdom in 2023, researchers delved into a quantitative investigation aimed at gaining a deeper understanding of how teachers employ technology across various teaching methods to enhance content delivery and engage students. The study also sought to explore the digital divide in technology usage, considering school settings and usage frequency. They gathered responses from a random sample of full-time K-12 public school teachers in a Mid-Atlantic state. Using a questionnaire developed from prior research, they examined how frequently educators in urban, rural, and suburban schools incorporated instructional technology into teaching methods such as cooperative learning, small group instruction, student-led research, and problem-solving. The study, which involved 423 participants, revealed significant differences in technology usage frequency among teachers from different school settings based on teaching modalities. These findings shed light on technology integration disparities and highlight the need for equity-focused frameworks and professional development opportunities to support educators in effectively using technology across various teaching approaches [17].

In a recent study by Anderson and Putman (2023), a collective case study involving three elementary-level special education teachers was conducted to explore their knowledge, decision-making, reasoning, and actions when integrating technology into instruction for students with learning differences. This research contributes to the existing body of knowledge on how teachers manifest Technological Pedagogical and Content Knowledge (TPACK) in their teaching practices, particularly within the realm of special education, an area that has been underrepresented in TPACK framework literature. Data collected from interviews and observations, coupled with stimulated recall, revealed that these teachers predominantly emphasized Technological Pedagogical Knowledge in their technology-related decisions. The findings underscored the intricate interplay between TPACK and Technological Pedagogical Reasoning and Action (TPR&A) as teachers made a range of decisions related to comprehension, content transformation, instructional interactions, evaluation, reflection, and adaptation to address diverse learning needs. These results suggest that professional development initiatives should not only enhance teachers' technological skills but also focus on refining their decision-making and reasoning processes when integrating technology in inclusive learning environments [18].

This study aimed to compare the learning experiences of Kenyan teachers participating in either an online or blended 12-week intensive teacher professional development program (TPD), focusing on early literacy development and the use of related software [19]. The research assessed TPD outcomes using surveys, course performance, and discussions, revealing that teachers showed improvements in domain knowledge, lesson planning, and comfort with teaching early literacy skills from pre- to post-tests. Interestingly, there were few significant differences between the online and blended formats, but teachers preferred the blended approach over online-only or in-person methods. Challenges related to resources and infrastructure were identified as obstacles to technology integration in classrooms, and some cultural challenges were noted for young learners

using Western-developed software. The study suggested that both online and blended formats are effective for TPD delivery to Kenyan teachers, but highlighted the need to address challenges for optimal technology-enhanced learning. Future research should consider regional variations, resource access, and teaching experience in different online formats when broadening the teacher sample [20].

This study addresses a research gap by focusing on the impact of mobile technologies on high school students, a demographic highly engaged with such tools, unlike most previous research that has concentrated on adults. The research introduces a specialized instructional design, incorporating the popular app Duolingo into English classes, to investigate how mobile technologies affect academic performance and social interaction among high school students. Carried out in a private school where English is compulsory, the study employs a mixed-method approach, combining quantitative and qualitative data. The research includes a needs analysis, standardized English tests, a social presence scale, and interviews. Purposive sampling was used to select 16 students each for the experimental and control groups, with eight participants voluntarily taking part in interviews. Analysis methods, such as t-tests for the social presence scale and descriptive analysis for interviews, revealed significant improvements in academic performance, particularly in writing, listening, and speaking, with minimal change in reading. Additionally, social presence increased significantly. Qualitative insights highlighted Duolingo's entertainment value, alignment with the curriculum, content diversity, accessibility, parental consent, and the importance of teacher guidance. The findings underscore the positive impact of Duolingo on academic performance and students' enthusiasm for its integration, prompting further exploration of the advantages and challenges associated with such technologies in education [21].

This study examines the impact of ongoing support for a computer/app-based early reading program called Headsprout Early Reading (HER) in primary schools. The research aimed to determine whether such support leads to improved outcomes. Twenty-two schools participated in a trial, with half receiving ongoing support throughout the school year, while the other half only received initial training and technical assistance. The study found that implementation support had no significant effect on reading outcomes or the core app-based component of HER. However, it did influence the implementation of other program elements, particularly in how educators responded to students' learning within HER. These findings suggest that well-designed computer/app-based instruction can yield positive results with minimal support and training. Still, further research is needed to ensure that technology complements teacher intervention effectively to provide additional support for students as required [22].

This study focused on STEM teachers who received National Science Foundation scholarships and their experiences during the COVID-19 pandemic. The study included 153 participants from universities in the Mountain West and Midwest regions. Through surveys and interviews in 2020 and early 2021, the study found that teachers prioritized instructional continuity but felt their professional needs were neglected. Most participants viewed school district actions negatively or neutrally. Experience influenced their perceived success, with all reporting lower success during the pandemic. Despite challenges, most intended to continue teaching short-term. Recommendations include improving teacher skills, especially in STEM, and creating crisis response plans for educators and administrators, particularly in high-needs districts [23].

In the realm of technology-enhanced teaching, teachers' beliefs about their competence play a pivotal role in shaping their professional effectiveness and the quality of instruction they provide. However, research on these competence-related beliefs, particularly in the context of technology integration, has been limited. This study has a dual objective: firstly, to assess the structure of a measurement tool designed to gauge teachers' competence-related beliefs, specifically in the

dimension of empowering learners, including its subdimensions of differentiation and active engagement, aligning with the European Framework for the Digital Competence of Educators (DigCompEdu); secondly, to investigate how these beliefs relate to teachers' reported use of digital technologies to improve classroom management, stimulate cognitive engagement, and foster a supportive learning environment. Analyzing data from 145 teachers, the study employs various structural equation modeling techniques, ultimately supporting a bifactor confirmatory factor analysis model. This model reveals a general factor representing empowering learners and two subdimensions signifying differentiation and active engagement. Notably, teachers' competence-related beliefs regarding differentiation and empowering learners positively correlate with their reported utilization of technologies to enhance instructional quality. These findings hold significance for teacher education, highlighting the importance of understanding how teachers perceive their competence in empowering learners, which, in turn, influences their use of technology to address diverse learning needs and promote active and creative engagement in the digital classroom[24].

This paper focuses on the development of a mobile-mediated professional development program designed for primary school teachers, emphasizing the utilization of mobile technology for anytime, anywhere learning. The study delves into learning design frameworks and strategies to facilitate effective teacher professional development (TPD) through mobile devices. It underscores the importance of adhering to design requirements and best practices in mobile-mediated TPD. The paper introduces a conceptual framework that incorporates various pedagogical and andragogical approaches, drawing inspiration from instructional design models such as the Integrative Learning Design Framework (ILDF), CSAM, RASE, Keller's ARCS, and the Technological Pedagogical Content Knowledge (TPACK) framework. This comprehensive framework integrates evidence-informed and theory-driven models and best practices, aiming to meet the instructional design needs for creating meaningful and impactful mobile-based learning experiences tailored for teachers [25].

This study investigates the curricular elements employed in blended physical education (PE) during the COVID-19 pandemic. It involved surveying 174 Spanish secondary PE teachers, with 120 men and 54 women participating. The findings indicate that for the non-face-to-face component, instruction primarily relied on challenge-based learning as a teaching strategy. Additionally, individual program learning design was prominent as a teaching approach, health-based PE served as a pedagogical model, and self-assessment emerged as the most frequently used assessment method. The study underscores the importance of considering factors such as the age of PE teachers and the socioeconomic background of families in implementing effective blended learning approaches in secondary education [26].

Table 1
Summary of empirical research focus and key findings

Research Focus	Empirical Findings
Use of 360° Video in Education	Demonstrates 360° video use in higher education Enhances content understanding, attitudes, and immersive learning experiences Guidelines for effective 360° video design [11]
Effectiveness of SQD Instrument in Measuring Teaching Strategies for Educators	SQD instrument to measure six teaching strategies Instrument reliability and validity
Impact of Coaching Tools in Professional Development for Teachers	No significant differences in teacher practices or student achievement Differences in effective coaching strategies among app users
Factors Influencing Teachers' Participation in PD Related to Technology	Technology's usefulness in classrooms PD link and teachers' intent to participate Utility of technology stronger than tech knowledge or self-awareness [16]
Teachers' Technology Use Across Teaching Methods	Discrepancies in technology use among teachers from different school settings across teaching modalities Technology integration disparities and the need for equity-focused frameworks [17]
TPACK Use by Special Education Teachers Integrating Technology	Teachers primarily use technological pedagogical knowledge in decision-making TPACK's role in addressing diverse learning needs in inclusive environments [18]
Comparison of Teacher Learning Experiences in Online vs. Blended TPD	Nearly equal impact of online and blended learning formats, preference for blended learning Challenges in technology integration and cultural differences [20]
Impact of Duolingo App in English Learning	Significant improvement in academic performance, particularly in writing, listening, and speaking Increased social presence and challenges in educational integration [21]
Support for Early Reading Program with Headsprout	Support implementation did not significantly affect reading success or core app-based learning mportance of well-designed tech instruction [22]
STEM Teachers' Experiences During COVID-19 Pandemic	Varied experiences among STEM teachers during the pandemic, implications on teaching and education Suggestions to enhance teacher skills, especially in STEM [23]
Relationship Between Teacher Beliefs and Technology Use in Teaching	Teachers' beliefs about their capabilities affect technology use for improved teaching quality Importance of understanding teacher beliefs for tech use [24]
Mobile-Mediated Professional Development Program for Teachers	Focus on mobile-based TPD, integrating learning design models and pedagogical approaches [25]
Technology Use in Physical Education during COVID-19 Era	Technology use in secondary PE teaching during remote learning Factors affecting technology use in education [26]

3. Results

3.1 Identification

The systematic review process involves three key phases. The initial phase entails identifying keywords and exploring related terms using thesauruses, dictionaries, encyclopedias, and existing studies. Once the relevant keywords have been determined, search strings were constructed for the Scopus and Web of Sciences databases, as outlined in Table 2. During this initial phase of the systematic review, a total of 602 papers were successfully retrieved from both databases.

Table 2
The search string

Scopus	TITLE-ABS-KEY (("Instructional technology" OR "Educational technology" OR "Technology integration" OR "E-learning") AND ("Teacher competence" OR "Pedagogical competence" OR "Teaching effectiveness" OR "Teacher training") AND ("Mediation" OR "Mediator" OR "Role" OR "Impact")) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (EXACTKEYWORD , "Teaching") OR LIMIT-TO (EXACTKEYWORD , "E-learning")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (DOCTYPE , "ar"))
WOS	("Instructional technology" OR "Educational technology" OR "Technology integration" OR "E-learning") AND ("Teacher competence" OR "Pedagogical competence" OR "Teaching effectiveness" OR "Teacher training") AND ("Mediation" OR "Mediator" OR "Role" OR "Impact") (Topic) and Open Access and 2019 or 2020 or 2021 or 2022 or 2023 (Publication Years) and Article or Proceeding Paper (Document Types)

3.2 Screening

During the initial screening phase, duplicate papers were eliminated. In this step, 3 articles were excluded. The second phase involved screening 92 articles using predefined inclusion and exclusion criteria established by the researchers.

One key criterion was that the literature had to be in the form of research articles published within a ten-year period (2013–2023). This timeframe was selected with 2013 as the minimum cutoff to ensure currency and relevance of the literature reviewed, allowing analysis of recently published research findings around the topic of focus. The ten-year period provides a sufficiently wide yet recent window to examine developments in the role of instructional technology mediating teacher competence.

Other forms of publications such as systematic reviews, reviews, meta-analyses and so forth were excluded. Additionally, the review focused exclusively on papers written in English. A total of 510 publications not meeting these criteria were excluded from the review.

3.3 Eligibility

In the third step, known as the eligibility phase, a total of 89 articles were identified. Besides the primary concentration on Malaysian context, the location criteria were expanded to encompass relevant Asian and regional studies. During this phase, a comprehensive review of the titles and key content of these articles was conducted to ensure they met the widened inclusion criteria and aligned with the research objectives. As a result, 64 reports were excluded for various reasons, including being unrelated to the field (n=21), having titles that lacked significance (n=21), or having abstracts that did not align with the study's objectives (n=22).

Titles that lacked significance refers to titles that were too general, vague or did not sufficiently indicate relevance to the research questions. The remaining 25 articles with clear and focused titles were deemed suitable for inclusion in the review, as summarized in Table 2.

Table 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Time line	2013 – 2023	< 2013
Literature type	Journal (Article)	Conference, Book, Review
Publication Stage	Final	In Press
Subject Area	Social Science	Besides Social Science/ Others

3.4 Systematic Review Stages

The systematic review process conducted in this study is depicted comprehensively through the PRISMA flow diagram in Figure 1. This flow diagram outlines the three key phases carried out sequentially, namely identification, screening, and eligibility assessment of studies.

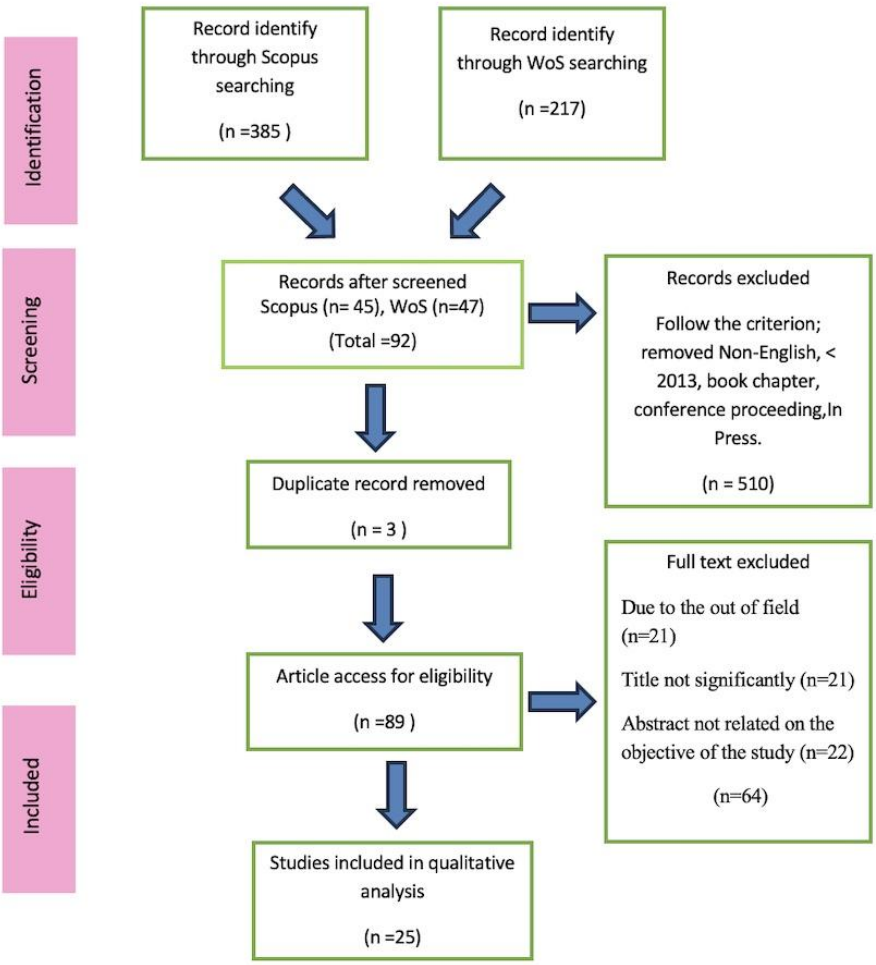

Fig. 1. Flow diagram of the proposed searching study [27]

3.5 Data Abstraction and Analysis

An integrative analysis was conducted using various examination techniques to analyze and synthesize different research designs including qualitative, quantitative, and mixed methods. The expert researchers focused on developing relevant topics and sub-topics within instructional technology and teacher competence.

The first phase involved data collection, where the authors thoroughly reviewed 25 papers to extract statements or information relevant to the research questions. Subsequently, in collaboration with an expert, the authors analyzed the landscape of instructional technology and teacher competence to identify and organize meaningful categories. This yielded three overarching themes: Technology in Education and Pedagogy; Teacher Training and Professional Development; and Learning Outcomes and Educational Research.

These themes were further refined by incorporating related sub-themes, concepts or ideas. Throughout this process, the authors maintained a detailed log documenting analyses, insights, questions and other relevant information for data interpretation. Any inconsistencies in theme development were resolved through collaborative discussion.

The themes were systematically reviewed and adjusted to ensure coherence and alignment. Two experts, one in education and another in technology, conducted thorough examinations to validate the rigor of the study. Their feedback was incorporated to refine the sub-themes and establish clarity, significance and adequacy, thereby ensuring domain validity. Adjustments were made based on the experts' valuable input.

The process of coding and identifying themes from the interview transcripts and survey data was inductive (Braun & Clarke, 2006). The researchers repeatedly read through the data to identify codes and clustered similar codes into overall themes and sub-themes that are reported in the findings section. The coding and thematic analysis process is depicted in Figure 2.

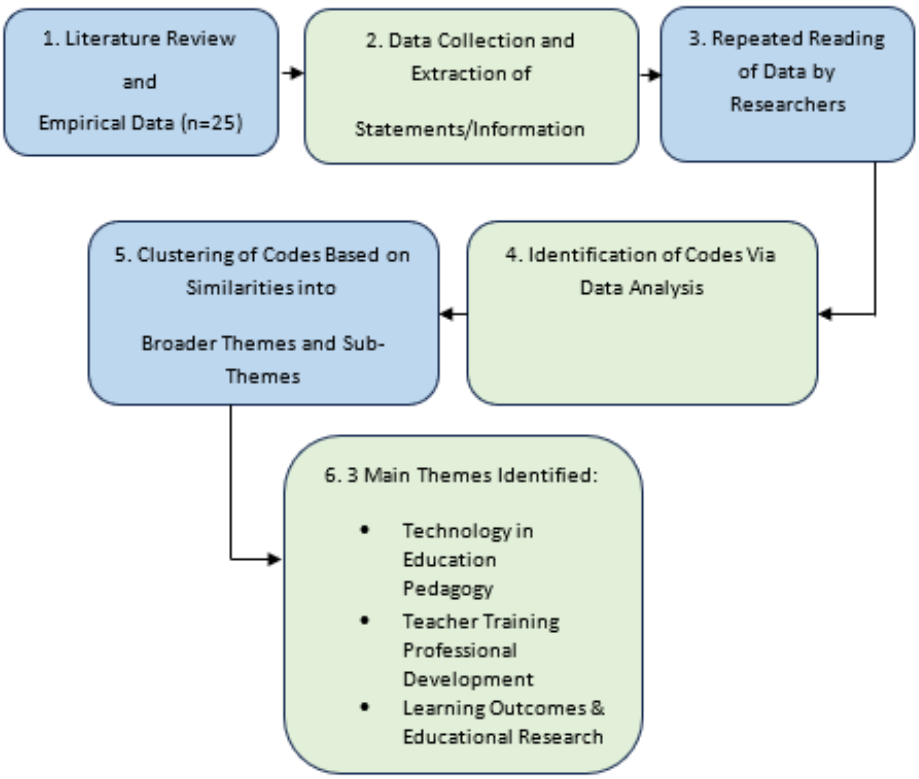

Fig. 2. Coding and thematic analysis process

4. Result and Finding

Instructional technology and teacher competence are critical aspects of education in Malaysia. As a significant concern in the realm of education, these factors have garnered increasing attention. Utilizing the search technique, 25 articles were identified and analyzed in this study. These articles were systematically categorized into three main themes:

Theme 1: Technology in Education and Pedagogy
Theme 2: Teacher Training and Professional Development
Theme 3: Learning Outcomes and Educational Research

This classification serves to provide a structured framework for examining the role of instructional technology in enhancing teacher competence and its impact on various aspects of education.

4.1 Theme 1: Technology in Education and Pedagogy

The first study delves into technology adoption for special education, relevant as it examines digital literacy training as a factor influencing SPED teachers. The research reveals a significant knowledge gap concerning technology's role in special education (SPED). Although technology holds potential for positive outcomes, it can also exacerbate disparities among SPED students, particularly given the COVID-19 pandemic. The study investigates factors enabling and hindering SPED teachers in using technology-enabled learning. Structural factors like resource allocation and digital literacy training emerge as influential in shaping technology adoption. These structural issues manifest as challenges for both teachers and students. Consequently, there is a pressing need for systemic changes in education to foster equitable, inclusive digital learning environments for diverse learners [28].

Turning to the second study, it scrutinizes factors influencing Information and Communication Technology (ICT) adoption among secondary school teachers in Johannesburg. The research finds teachers more inclined to incorporate ICT when they perceive it as enhancing teaching and learning. Ease of use also emerges as a key factor. These findings emphasize the importance of user-friendly design and effective training to encourage ICT integration. The study further suggests integrating e-learning into teacher training, not only cultivating more favorable ICT attitudes but also enabling practical classroom implementation. It also advocates a top-down approach, with the Department of Education requesting ICT usage plans from schools and incentivizing integration, starting at the school level, to drive ICT adoption in South African education [29].

This study investigates teachers' competence-related beliefs, particularly in the dimension of empowering learners, and its subdimensions of differentiation and actively engaging learners based on the European Framework for the Digital Competence of Educators (DigCompEdu). It also explores the relations between these beliefs and teachers' reported use of digital technologies for classroom management, cognitive activation, and creating a supportive climate. Analyzing data from 145 teachers, the study confirms a bifactor model, with a general factor of empowering learners and two subdimensions. The findings reveal that teachers' competence-related beliefs, particularly regarding differentiation and empowering learners, are positively correlated with their reported use of technology to enhance instructional quality. This study highlights the importance of understanding teachers' beliefs about empowering learners and their connection to instructional quality in technology-enhanced teaching, emphasizing the relevance of addressing diverse learning needs and promoting active engagement in teacher education [24].

The third research study casts its focus on the role of mobile educational technology, particularly the School in a Box intervention, in enhancing teacher skills to facilitate quality education within a public primary school in Mozambique. This study accentuates the paramount importance of quality education, especially in the context of participatory pedagogical practices fostering locally relevant and meaningful learning experiences. These practices are instrumental in empowering children with self-directed learning skills. Additionally, the research underscores the value of teacher professional development and the establishment of peer support networks within the teaching community. These components serve as catalysts for teachers to spearhead initiatives that introduce mobile educational technology in resource-constrained learning environments in Sub-Saharan Africa. The study integrates the School in a Box tool with Vygotsky's zone of proximal development framework, seeking to understand how teachers can effectively incorporate this technology into the local curriculum and learning environment, ultimately enhancing the quality of education provided. [30]

The next study addresses the educational challenges posed by the COVID-19 pandemic, which forced a sudden shift from traditional face-to-face teaching to online learning. Recognizing the need to enhance preservice teachers' psychological and pedagogical competencies for effective online teaching, the study introduces the web-based T.E.A.C.H. program. Comprising five modules, each emphasizing psychological dimensions (creativity, curiosity, love of learning, judgment, and perspective) applied to online teaching's key aspects, the program was evaluated through a quasi-experimental design involving 314 preservice teachers. The results demonstrated the program's effectiveness in enhancing psychological competencies, fostering positive attitudes toward online learning and teaching, boosting self-efficacy for online teaching, increasing intentions to utilize technology for teaching, and improving online pedagogical skills. These findings underscore the program's potential to benefit school leaders, educators, and professional development providers seeking to enhance online teaching practices in the face of evolving educational landscapes. [31].

Amid the COVID-19 pandemic's surge in e-learning, this study addresses a notable gap in the literature concerning emotional intelligence (EI) in online education, particularly in the context of hospitality and tourism students. Employing a two-round Delphi approach, the study aimed to understand the typical EI behaviors exhibited by students in e-learning environments. The findings reveal that in such settings, students commonly demonstrate high self-awareness but lower levels of self-management, social management, and relationship-building competence. While previous EI research predominantly centered on employee performance, this study extends its scope to the realm of education, offering valuable insights for hospitality and tourism educators and researchers. These findings underscore the need to consider EI as a vital factor in the effectiveness of e-learning, emphasizing its potential impact on students' emotional development and learning outcomes in this digital educational landscape [32].

The subsequent study investigates the impact of the mandatory shift to online teaching due to Covid-19, specifically in quantitative subjects, by employing the Technological Pedagogical Content Knowledge (TPACK) model. Through a structured questionnaire administered to 215 students, the research employs both quantitative analysis, including Student's t-test, and sentiment analysis of open-ended responses. The findings reveal that implementing e-learning within the TPACK framework results in redesigned lessons that foster greater student engagement and retention. Notably, students with a preference for in-person learning positively evaluate the method and tools used, suggesting that the strategic incorporation of technology in the classroom enhances acceptance and reduces dropout rates. This evidence-based research contributes to addressing the deficit in suitable conceptual models for teacher training, emphasizing not only technology usage but also its effective application, encompassing the requisite knowledge, skills, and competencies for successful implementation [33].

The article delves into the ongoing challenge of integrating technology and pedagogy within formal education, a process closely tied to the paradigm shifts brought about by the Fourth Industrial Revolution in the 21st century. Despite the changing landscape of knowledge dissemination, schools remain pivotal in shaping the education and civic development of new generations. This study specifically investigates the role of veteran teachers, educators with extensive experience, in advancing towards a more technologically-driven education landscape. The research, conducted with 38 pre-school and K-12 teachers in Portugal, emphasizes the importance of understanding these educators' perceptions and attitudes towards technology as pedagogical tools. Additionally, the study explores how teacher-oriented interventions, such as the training program in question, can influence the identity and practices of veteran teachers, offering potential avenues for meaningful change in the education sector [34].

Fig. 3. Rekindle+50 training design

Figure 3 depicts the Rekindle+50 training program, designed to rejuvenate the commitment of experienced educators aged over 50 towards teaching and curricular innovation through the integration of mobile technologies in educational settings. This comprehensive program was collaboratively developed by two education sciences faculties in Portugal, in partnership with two teacher training centers from central and northern regions of the country, actively engaged in the "Future Classrooms" initiative. Figure 3 further illustrates that the training regimen spanned nine sessions, totaling 50 hours, comprising 25 hours of face-to-face instruction and 25 hours of self-directed learning. Within the program, participants were guided to enhance their pedagogical skills in mobile device utilization, promote their adoption among both teachers and students, contemplate inventive learning scenarios, create new learning environments, and foster the application of innovative pedagogical models. Notably, the figure showcases the program's focus on designing activities aligned with proposed pedagogical approaches, implementing these activities, and generating digital resources for mobile device integration in educational contexts. To ensure competence consolidation and enhance educators' confidence in implementing innovative pedagogical strategies during the digital migration, non-formal follow-up sessions were conducted in situ, as illustrated in Figure 3. Moreover, the program featured special guest appearances, typically by academics, to stimulate discussions on critical aspects of the course.

4.2 Theme 2: Teacher Training and Professional Development

This research delves into the impact of the shift from traditional to online learning on students' entrepreneurial education and self-efficacy, as well as their intentions towards entrepreneurship. Conducted in several universities in Malang, Indonesia, the study employs quantitative methods and structural equation modeling to examine this phenomenon. The findings reveal a significant connection between e-learning, entrepreneurial education, and self-efficacy, with lecturer competence, performance expectancy, and facilitating conditions playing crucial roles. Furthermore, a strong link is identified between entrepreneurship education and entrepreneurial intentions. Importantly, the study emphasizes the mediating role of self-efficacy and entrepreneurship education in shaping teachers' competence and their intention to promote entrepreneurship. The implications suggest a need for lecturers to enhance their competency in delivering meaningful entrepreneurship education, encompassing students' psychological aspects. Collaboration with the government is recommended to provide adequate infrastructure and internet quality to support online learning. Overall, this research offers a valuable strategy, particularly in the context of the COVID-19 pandemic, for promoting entrepreneurship education through e-learning, fostering technological familiarity, and enhancing entrepreneurship promotion even under regular circumstances. [35].

In this mixed-method study involving 85 pre-service teachers in a teacher-development course, the research explored how design practices influenced and promoted these future educators' beliefs about technology integration and their awareness of scientific inquiry. The goal of incorporating design practices into teacher-development courses was to enhance pre-service teachers' understanding and capabilities in design practices and their applications in education. The study revealed a recent integration of design practices with scientific inquiry to deepen pre-service teachers' contextual comprehension of technology integration in STEM education. Despite the potential impact of design practices on scientific inquiry in teacher training, a challenge existed in capturing in-situ data regarding how pre-service teachers' beliefs in technology integration evolved through these practices. Furthermore, empirical investigations into how design practices fostered pre-service teachers' experiences in scientific inquiry were limited. To address these gaps, the study employed text mining and qualitative thematic analysis. The results indicated that pre-service teachers indeed enhanced their technology-integration beliefs and their awareness of scientific inquiry through engagement with design practices. This study carries important implications for teacher training programs, emphasizing the value of design practices, and also highlights the potential utility of text mining as an alternative assessment method for measuring design learning experiences.[36]

This literature review delves into the evolving landscape of higher education, with a particular emphasis on the increasing impact of e-learning, especially in the form of blended learning. While numerous studies have attempted to compare face-to-face teaching with online or blended formats in terms of learning outcomes, student satisfaction, and course completion rates, this review underscores the multifaceted nature of teaching and learning, suggesting that multiple factors influence the educational experience beyond the teaching format alone. Focusing on professional bachelor education and teacher training, the review seeks to identify the factors that significantly affect e-learning and blended learning experiences. It reveals that several factors stand out as dominant contributors, including the presence of educators in online settings, interactions among students, teachers, and course content, and well-designed connections between online and offline activities, as well as between campus-related and practice-related learning experiences. While these factors are highlighted, the review also questions the relevance of research that primarily seeks to

compare individual formats of teaching and learning, emphasizing that education is a complex process influenced by a multitude of factors. The review draws from 44 peer-reviewed articles and papers published between 2014 and 2017, offering valuable insights into the dynamics of e-learning and blended learning in higher education.[37]

This study investigates the profound impact of the COVID-19 pandemic on education, specifically in Indonesia, where traditional face-to-face teaching has shifted to online learning due to government policies necessitating learning from home. Focusing on elementary school teachers in East Kalimantan province, the research employs a quantitative approach and utilizes Structural Equation Modeling (SEM) for statistical analysis. The study's findings reveal that the Indonesian government's policy of teaching from home significantly influences teacher competence in utilizing e-learning tools. Furthermore, this policy also demonstrates a positive impact on teachers' competence in using social media as an educational resource. This underscores the effectiveness of government policies in driving teacher adaptation to online teaching methods during the pandemic, highlighting the pivotal role of policy decisions in navigating the challenges posed by the global health crisis. [38]

This study investigates the intricate dynamics of self-regulated learning, teaching effectiveness, scientific literacy, and their impact on multidisciplinary learning outcomes within an online learning context. Analyzing data from 242 participants to establish scale structure and then confirming it with 922 participants, the research uncovers several significant findings. Quality online material emerges as a critical mediator, connecting scientific literacy, self-regulated learning, teaching effectiveness, and multidisciplinary learning outcomes. Notably, quality online material and teaching effectiveness are identified as the most influential factors contributing to enhanced multidisciplinary learning outcomes. Additionally, scientific literacy serves a dual role, moderating both the relationship between self-regulated learning and online material quality and the connection between teaching effectiveness and multidisciplinary learning outcomes. These results underscore the pivotal role of quality online materials and effective teaching in online education, highlighting the importance of scientific literacy as a moderator in facilitating successful multidisciplinary learning outcomes in this context. [40].

This study addresses the critical need for preparing teachers to effectively transition from face-to-face to online instruction, a demand heightened by the COVID-19 pandemic. While technology integration in education has been emphasized, the focus on teacher preparedness for online teaching has been limited. Consequently, many educators lack the necessary resources and training for high-quality remote instruction. The study explores the potential of Massive Open Online Courses (MOOCs) as a scalable solution to build teacher capacity in remote teaching. Through a mixed-methods approach, the research examines the challenges faced by teachers in remote instruction, the perceived impact of MOOCs on their ability to teach remotely, and participation data. The findings highlight that MOOCs aligned with teachers' needs can significantly enhance their confidence in remote teaching and increase participation rates, emphasizing the potential of MOOCs for teacher professional development. This study underscores the importance of designing MOOCs that cater to specific teacher requirements and can effectively address the challenges associated with remote instruction, offering valuable insights for both practice and policy in teacher education and professional development. [41].

This paper delves into the realm of teacher competencies, emphasizing the critical distinction between pedagogical and professional competencies. While pedagogical competence centers on the teacher's ability to organize and facilitate the educational process, professional competencies encompass the commitment to implementing effective teaching practices. In comparison, the research aims to identify and expand upon the professional competencies of teachers, recognizing

that changes in the educational system have a direct impact on these competencies. Moreover, the study underscores the need for enhancing teacher qualifications by improving working conditions, equipping schools with modern educational technology, revising curriculum structures, optimizing educational efficiency, and implementing systematic teacher assessment. These proposed changes aim to elevate the teacher's role and standing within society and, in turn, foster more successful educational outcomes.[42]

In a different context, this paper presents the findings of a pre-registered cluster randomized controlled trial that investigated the impact of a media education intervention aimed at addressing the growing concerns surrounding the intensive use of smartphones and its effects on the well-being of young people. The study specifically targeted teachers and schools, assessing the effects of a teacher training course on 10th-grade students. In contrast, the results, after controlling for baseline measures, revealed a notable decrease in smartphone pervasiveness and problematic use among the students who received the intervention. It is worth noting that the positive effects were more pronounced among girls, particularly in reducing withdrawal symptoms and increasing subjective well-being. However, in contrast, no significant impact was observed on the students' digital skills. These findings underscore the effectiveness of media education interventions that emphasize screen time management and conscious mobile device usage in the school curriculum, offering valuable insights for the development of such programs in an era of constant connectivity.[43] .

This study assessed the impact of the digital learning program, SkooolNigeria.com, co-sponsored by the Shell Petroleum Development Company of Nigeria Limited Joint Venture, on students, teachers, and communities in remote areas of Nigeria. The findings reveal that the digital learning tools, environment, and content were deemed adequate in terms of accessibility, availability, suitability, relevance, and currency. Importantly, the program had a significantly positive impact on students, as evidenced by increased interest in science subjects, improved class participation, and enhanced teacher competence. Additionally, there was a notable rise in the number of students choosing science subjects since the program's inception. To build upon these positive outcomes, the study recommends extending the digital learning program to the Junior Secondary School (JSS) level, establishing sustainability mechanisms, implementing close monitoring and evaluation processes, providing ICT training for teachers, ensuring proper maintenance of the program's tools, and establishing a complaint and protocol system for students and parents. These recommendations underscore the potential of digital learning technology to improve educational outcomes, particularly in underserved regions. [44].

This study focuses on teachers' digital skills for helping students with disabilities, especially in the context of COVID-19. It found that many teachers in Andalusia, Spain, have a basic level of digital competence, especially in higher education. The study also discovered that factors like gender, motivation, attitude toward technology, and having students with special needs affect teachers' digital skills. This highlights the need for more training for teachers to better support students with disabilities. The study also suggests some practical digital tools that can help in different situations. [45]

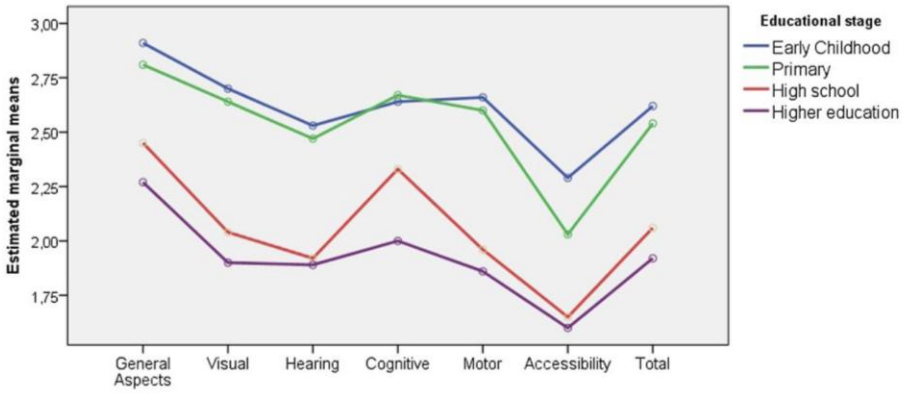

Fig. 4. Knowledge of the use of ICT resources to assist people with disabilities, at each educational stage

At every educational stage, from early childhood to higher education, knowing how to use ICT resources to assist people with disabilities is crucial for creating inclusive learning environments. These resources can range from adaptive apps for early learners to screen readers and accessible e-books for college students. Understanding and implementing these technologies ensures that students with disabilities have equal access to educational materials and opportunities.

4.3 Theme 3: Learning Outcomes and Educational Research

This study [46] examines selection of teaching models like Flipped Learning in mathematics, relevant for analyzing technology integration, online collaboration and impacts on practice.

This study investigates the factors influencing the selection of various teaching models and methodologies in mathematics education, particularly focusing on the role of pedagogical models like Flipped Learning and active methodologies such as Project-Based Learning and Gamification. The research involved 73 teachers in the Autonomous City of Melilla and utilized a questionnaire covering mathematics and teacher training, information and communication technology (ICT) usage, resources, and collaboration. The findings revealed that there were significant positive associations between the adoption of the Flipped Learning model, Project-Based Learning, and Gamification, and various aspects of teaching practices, ratios, and mathematics teacher training indicators. Additionally, the study indicated that Project-Based Learning had a negative association with two specific teaching practice indicators. Ultimately, the study highlights the importance of online information exchange, collaborative participation, and the integration of digital technologies and educational software in mathematics instruction, as these factors significantly influenced the choice of the Flipped Learning model and active teaching methodologies among educators in the study's context. [46].

This quantitative study aimed to assess the influence of ICT equipment availability, accessibility, and teachers' ICT training on the integration of ICT into curriculum-related activities among secondary school teachers in the Groot Letaba Circuit, South Africa. Data from 146 participants across twelve schools revealed a significant scarcity of ICT resources, with the exception of TVs, photocopiers, and laptop/desktop computers. The study found that this lack of ICT equipment, as well as insufficient utilization of available resources, had a negative impact on teachers' instructional and curriculum administration functions. Additionally, although some teachers had received ICT training, it had minimal or no effect on their confidence and abilities to incorporate ICT into their teaching practices. These findings underscore the pressing need for intervention by various

stakeholders, including the Department of Education, school management, and private partners, to address these challenges and enhance teachers' readiness and confidence in effectively utilizing ICT in education [47].

This study investigates the impact of an intervention program designed to train teachers in collaborating with their students in the creation of digital games, aiming to enhance the integration of ICT in education. The research involved 63 active teachers enrolled in an M.Ed. program at a teacher education college, utilizing both quantitative and qualitative methods. The findings reveal that prior to the intervention, teachers often struggled with resistance to changing their teaching patterns, but after participating in the program, they exhibited higher intrinsic motivation to learn innovative pedagogical-technological approaches and a greater sense of mastery in 21st-century skills, leading to a more positive attitude towards classroom collaboration. Qualitative results emphasized the importance of professional development, conceptual and emotional changes, and teachers' perceptions of learners in the context of adopting this collaborative, constructivist teaching approach. The study underscores the need for ongoing teacher training to transform teaching-learning processes, promote constructive principles, 21st-century skills, and collaboration between teachers and students in a digital environment, signaling the potential for rethinking teacher training. The study also suggests the necessity of larger-scale research with control groups to further explore the effectiveness of this pedagogical model and its broader implications for education and teacher preparation [48].

This study delves into the factors influencing student learning outcomes in a distance learning context, particularly examining the impact of distance teaching implementation, online material guidance, and teaching effectiveness. The findings demonstrate that both distance teaching implementation and online material guidance have a positive effect on student learning outcomes, highlighting the significance of these elements in the educational process. The study further suggests a curvilinear relationship between teaching effectiveness and learning outcomes, indicating that an optimal level of teaching competence is crucial for maximizing student learning. Additionally, the research underscores the importance of competent instructors in enhancing student outcomes in distance learning, emphasizing the need for quality online materials tailored to specific instructional objectives and learning strategies for each course. Lastly, the study acknowledges the potential of interactive distance learning environments, particularly those involving video conferencing, in reducing student alienation and increasing enrollment, offering valuable insights into the evolving landscape of distance education [49].

Focusing on Human E-learning Interaction (HEI), this interdisciplinary research integrates concepts from instructional communication and instructional technology and applies them to e-learning systems, focusing on academic stakeholders' roles and competencies. The purpose of this research is to propose and design an E-learning User Interface (ELUI) using web programming languages to support instructional communication in an online learning environment. The proposed interface, considering both students' and teachers' perspectives, identifies several new features that contribute to success in interactive e-learning systems in academic organizations. A sample of 102 students and 10 teachers selected from a university in Canada were asked to browse the ELUI proposed in this study and provide feedback. Using a mixed methods approach, this study employed both quantitative and qualitative methods of analysis to provide a more robust understanding of student and teacher perceptions of the ELUI. Students' attitudes toward use of the interface were analyzed using the Technology Acceptance Model, while teachers’ perceptions were analyzed through content analysis of semi-structured interviews. The results of regression analysis showed that perceived ease of use and perceived usefulness of ELUI are predictive of student attitude toward future use of the ELUI. The results of the interviews revealed that teachers believe the ELUI would be

efficient, particularly with adequate training and support, though were unable to comment on the cost effectiveness of e-learning systems. The overall results suggest that academic decision-makers should adopt instructional communication features in e-learning systems [50].

In response to the COVID-19 pandemic and the subsequent shift towards online teacher training, this research examines the factors influencing teachers' intentions to participate in such training. The study investigates the impact of the Theory of Planned Behavior (TPB) alongside the elements of ability, opportunity, and motivation. Data collected from 142 respondents across four different universities in Bangladesh reveal significant influences on teachers' intentions, particularly through perceived behavior control, motivation, and ability. Notably, this research model expands upon the TPB by empirically incorporating the dimensions of ability, opportunity, and motivation. These findings are valuable for academia as they provide insights into how to effectively motivate teachers to engage in online training during pandemic-induced lockdowns, thus enhancing professional development in the education sector [51].

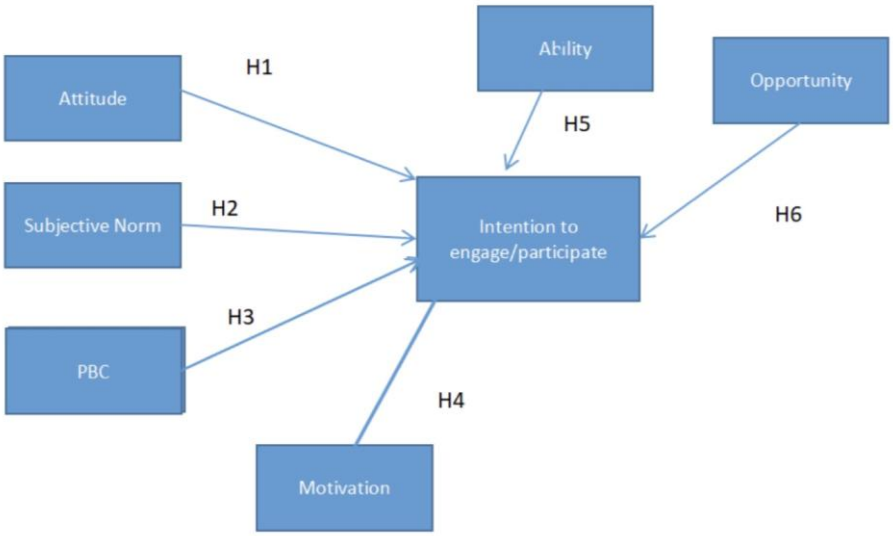

Fig. 5. Proposed research model

In this research, a structural model was utilized to analyze the relationships between different factors. Through statistical tests, it was determined that out of six hypotheses, three were supported as significant. Firstly, a significant connection was found between 'PBC' (Perceived Behavioral Control) and 'intention' (the intention to participate), indicating that when individuals felt they had more control, their intention to participate increased. Secondly, a significant relationship emerged between 'motivation' and 'intention,' suggesting that higher motivation led to a greater intention to participate. Lastly, 'ability' and 'intention' were strongly linked, indicating that having the ability to participate influenced one's intention. However, no significant relationships were found between 'attitude,' 'subjective norm,' 'opportunity,' and 'intention to participate in online teacher's training' in this research's analysis.

5. Conclusion

These studies collectively emphasize the critical role of technology in modern pedagogy, with a particular focus on diverse educational contexts and the challenges and opportunities posed by digital learning environments. From addressing disparities in special education settings to examining

the preferences and perceptions of teachers and students regarding technology integration, the studies highlight the need for strategic planning, professional development, and user-friendly interfaces.

The overarching theme in this collection of studies centers on teacher training and professional development, particularly in the context of digital education and technology integration. These studies collectively highlight the critical role of teacher competency and preparedness in adapting to new pedagogical paradigms, especially in response to challenges like the COVID-19 pandemic.

The studies in this collection primarily focus on various aspects of learning outcomes and educational research, specifically within the context of technology integration and instructional methodologies. They shed light on critical factors influencing teaching practices, teacher readiness, and student learning in today's digital age.

In conclusion, these studies collectively emphasize the intricate relationship between teaching methodologies, technology integration, and student outcomes. They provide valuable insights into the challenges and opportunities associated with digital education, offering guidance for educators, institutions, and policymakers seeking to enhance teaching practices and improve educational outcomes in a rapidly changing educational landscape.

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