Multidisciplinary Output Research For Actual and International Issue (MORFAI Journal) ISSN (e): 2808-6635
Volumes 5 No. 3 (2025)

ANALYSIS OF TEACHER ABILITY IN USING LEARNING TECHNOLOGY: SYSTEMATIC LITERATURE REVIEW (SLR)

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Received	: 01 August 2025	Published	: 28 September 2025
Revised	: 20 August 2025	DOI	: https://doi.org/10.54443/morfai.v5i3.4137
Accepted	: 22 September 2025	Link Publish	: https://radjapublika.com/index.php/MORFAI/article/view/4137

Abstract

This study aims to synthesize findings from the latest scientific literature related to teachers' ability to integrate learning technology. A Systematic Literature Review (SLR) approach was used to examine 20 articles published between 2019 and 2024, focusing on factors influencing teachers' technological competence. The review results indicate that teachers' competence is influenced by four main aspects: (1) ongoing professional training, (2) availability of infrastructure and institutional support, (3) teachers' self-efficacy, and (4) digital attitudes and literacy. Despite the increasing adoption of technology, challenges remain in teachers' pedagogical ability to integrate technology effectively. This study recommends improving training based on the TPACK model and strengthening school policies to support digital transformation in education.

Keywords*: teacher competency, learning technology, TPACK, technology integration, SLR.*

INTRODUCTION

The rapid development of digital technology has had a significant impact on various aspects of life, including the education sector. Facing the challenges of the 21st century, integrating learning technology into the curriculum is a necessity to improve the quality and relevance of education (OECD, 2020). The use of various technologies such as Learning Management Systems (LMS), Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence (AI) offers great potential for creating more interactive, personalized, and effective learning environments (Sørensen et al., 2021). However, the use of technology in learning cannot be separated from the central role of teachers. The success of technology integration in the classroom depends heavily on teachers' competence in selecting, using, and adapting technology pedagogically. Without adequate skills, technology risks becoming merely a passive tool unable to significantly impact student learning outcomes. Referring to Government Regulation of the Republic of Indonesia No. 19 of 2005, teachers are required to possess four core competencies: pedagogical, personality, professional, and social. Pedagogical competency encompasses the ability to plan, implement, and evaluate learning, as well as utilize technology to develop students' potential.

Professional competency encompasses in-depth mastery of learning materials, adaptation to technological developments, and the ability to apply appropriate learning methods, media, and evaluation. Personality and social competencies, on the other hand, play a role in building character, communication, and collaboration, supporting an inclusive digital learning ecosystem. In line with the demands of digital transformation in education, teachers are required not only to master technology but also to be able to synergistically integrate it with pedagogical approaches and teaching materials. The Technological Pedagogical Content Knowledge (TPACK) framework serves as a reference for measuring teacher readiness and competence in these areas. Previous studies have shown that the success of TPACK implementation is influenced by several factors, such as professional training, institutional support, and the readiness of technology infrastructure in schools. Although many studies have examined teachers' abilities in using learning technology, most of these studies are still limited to the context of certain regions or levels of education, so a more comprehensive study is needed.Therefore, a systematic literature review is needed that synthesizes various findings to provide a more comprehensive picture of the actual conditions and factors that influence teachers' ability to integrate technology into

learning. The problem formulation in this study is: What are the factors that influence teachers' ability to use learning technology based on previous research results? This study contributesin the form of a synthesis of the latest literature that can be used as an empirical basis for developing teacher training policies, strengthening the teacher professional education curriculum, and formulating strategies for implementing learning technology at various levels of education.

LITERATURE REVIEW

1. Teacher Competencies in the Context of Learning Technology

   Teachers' ability to integrate learning technology is a crucial indicator for improving the quality of education. This mastery extends beyond technical aspects to include the ability to apply technology pedagogically in the learning process (Koehler & Mishra, 2009). However, according to Setiawan et al. (2022), most teachers still experience difficulties in selecting and adapting learning technology to suit the characteristics and needs of their students. Research at the Vocational High School (SMK) level shows that the majority of teachers have utilized technological devices such as gadgets, projectors, and various applications in the learning process, both online and offline. This demonstrates a real effort to utilize technology as a supporting medium for learning activities. One relevant conceptual framework for integrating technology into education is the Technological Pedagogical Content Knowledge (TPACK) model. This model encourages teachers to design innovative learning through the use of digital media, ongoing training, and professional collaboration. This approach has been proven to improve teacher professionalism, encourage innovation in teaching practices, and strengthen student engagement in the learning process. Furthermore, mastery of competencies within the TPACK framework significantly contributes to the successful implementation of digital-based learning. In this context, Information and Communication Technology (ICT) plays a role in strengthening teachers' pedagogical competencies, encompassing aspects of planning, implementation, and evaluation of learning. Improving these competencies requires support in the form of adequate training and the provision of infrastructure that supports comprehensive technology integration. Technical training, both in the form of group and individual guidance, has proven effective in improving teachers' mastery of information technology. Improving teacher scores on the Pedagogical Competency Test (TPK) can also accelerate the educational transformation process through the application of ICT in teaching and learning activities. At the early childhood education level, some teachers have begun to understand and apply technology in learning activities. However, they still need further training, adequate infrastructure, and ongoing mentoring to ensure optimal technology integration.

2. TPACK Model in Analyzing Teacher Competence

   The Technological Pedagogical Content Knowledge (TPACK) model is a widely used theoretical framework for measuring teacher competency in integrating technology. This model emphasizes the importance of synergy between three types of knowledge: content, pedagogy, and technology. Studies (Misra et al., 2020; Fatimah, 2021) show that teachers with strong TPACK competency tend to be more effective in designing technology-based learning. Several other studies have shown that the TPACK model significantly contributes to improving teacher competency in integrating learning technology. Khotimah et al. (2019) and Suyanto et al. (2019) found that systematic academic and professional training can strengthen the three dimensions of TPACK, which in turn has a positive impact on the quality of technology integration in the learning process. Meanwhile, Simangunsong et al. (2024), through a bibliometric study, noted a surge in the number of scientific publications related to TPACK since 2022, reflecting the growing academic attention to the relevance of this framework in supporting the transformation of 21st-century education. Support from empirical studies also strengthens the effectiveness of this model in practice, as found by Fatimah (2021), where 87% of junior high school science teachers in Central and East Java have TPACK competencies in the good category, although some still require further training and infrastructure support. Similarly, research by Nasar et al. (2020) on junior high school/Islamic junior high school teachers in Ende City showed quite high TPACK competency results despite still facing challenges in technological and pedagogical readiness. In addition, at the pre-service teacher education level, TPACK-based training has also been shown to improve prospective teachers' readiness to integrate technology into teaching practice, as stated by Diamah et al., (2022) who showed that a two-week intensive training program was able to significantly improve students' perceptions and competencies, with a major effect on the ability to integrate technology into learning.

3. Factors that Influence Teacher Ability

Research by Rahmawati (2023) emphasized that ongoing, applicable technology training can increase teacher confidence in implementing learning technology. Teachers' ability to use learning technology is influenced by several key factors, including:

a. Professional training and development(In-service training)
Ongoing and applicable training has proven crucial. For example, a study by Nurul Hakim (2024) emphasized the importance of ongoing training, collaboration between teachers, and school management support in strengthening teachers' ability to use ICT in learning. Furthermore, Mustopa et al. (2024) highlighted that training focused on technology integration is crucial for increasing teacher confidence in its use, overcoming infrastructure limitations, and achieving efficient use of technology in the teaching and learning process.

b. Institutional support and technological infrastructure
The digital divide and limited infrastructure are major obstacles. Zulfa (2021) stated that uneven infrastructure hinders the optimal use of learning technology.

c. Personal attitudes and readiness for digital change
Teacher readiness for the digital era is heavily influenced by factors such as age, educational background, and accessibility to technological infrastructure. Younger teachers tend to be more adaptable to digital change. Furthermore, digital transformation demands that teachers improve their pedagogical and digital competencies, although gaps in access and readiness often pose obstacles.

d. Experience and self-confidence (self-efficacy)
Teachers' confidence in using technology is also determined by the training they receive. At Muhammadiyah Sipirok Elementary School, digital-based numeracy literacy training has been shown to significantly improve teacher self-efficacy through a blended learning approach. Training designed to improve teacher self-efficacy directly impacts their engagement in learning.

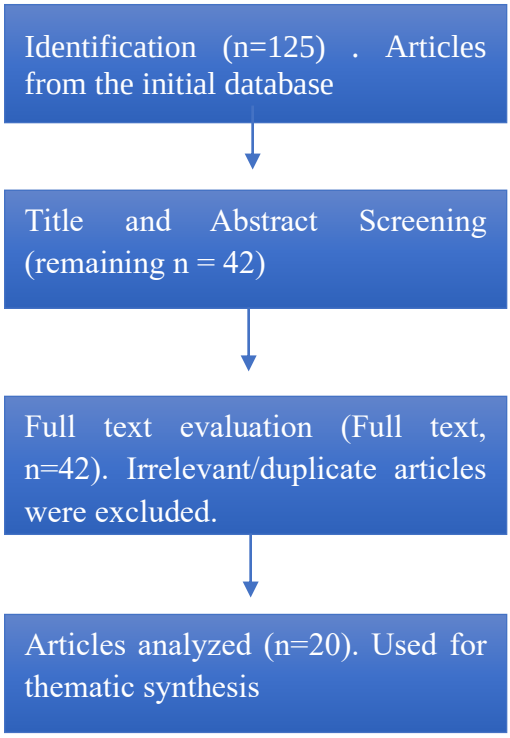
4. Implementation Challenges and Gaps

The implementation of technology in learning still faces significant challenges among teachers in Indonesia. Some of the main obstacles commonly encountered include limited supporting facilities, low levels of digital literacy, and minimal policy support from educational institutions (Sari & Nugroho, 2022). This situation demonstrates that digital transformation in education requires not only individual readiness but also systemic readiness. The main obstacles to the implementation of learning technology include low teacher digital literacy, limited technological infrastructure, and a lack of motivation to adapt, particularly in remote areas that still face obstacles to internet access and digital devices. This is reinforced by the results of a policy analysis conducted by Yulastri et al. (2023), which revealed that teachers' low digital skills are exacerbated by several structural factors, such as a lack of adequate infrastructure, an insufficiently flexible curriculum, and an evaluation system that is still oriented towards mastery of material rather than 21st-century skills.

Although some schools have provided basic facilities such as computer labs or projectors, the integration of technology into learning has not been optimal. Other challenges hindering the effective implementation of technology include limited ongoing professional training, a lack of technical support from experts, and school policies that do not support all subject areas equally. Furthermore, these implementation challenges are also found in international contexts. Atabek's (2019) study on the integration of educational technology in Turkey and Mongolia showed that the biggest obstacles were not only related to hardware availability, but also the lack of technical and pedagogical training for both in-service and pre-service teachers, the limited availability of digital content relevant to local needs, and the absence of an incentive system that encourages innovation and teacher professional development. Furthermore, most existing research tends to focus on specific levels or regions, such as studies of elementary school teachers in urban areas or vocational high school teachers in specific provinces. This situation indicates a gap in the literature, so a more comprehensive and cross-contextual study is needed to formulate a technology implementation strategy that is more inclusive and adaptive to the diversity of educational conditions in Indonesia.

METHODOLOGY

This study used a Systematic Literature Review (SLR) approach based on the PRISMA protocol. Articles were collected from Google Scholar, ScienceDirect, and ERIC databases, with keywords related to teacher competency and learning technology. From the initial 125 articles, 20 articles were selected based on specific inclusion criteria (published between 2019 and 2024, teacher focus, and topic relevance). Data were analyzed thematically to identify key factors influencing teachers' ability to integrate technology.



RESULTS AND DISCUSSION

Based on the selection process and literature analysis of 20 articles on topics relevant to teachers' ability to use learning technology that have been reviewed in depth, the following findings were obtained:

1. Ahmad's (2021) journal concluded that the use of Google Classroom is effective in improving student learning outcomes, participation, motivation, and technological skills. This platform significantly supports efficient distance learning, especially during the COVID-19 pandemic, and provides access to education for students in remote areas. While it has many advantages, such as ease of use and access to learning resources, it also has disadvantages, such as a lack of social interaction and limited technological skills among some teachers and students. The differences in results between studies indicate the need for further research to identify factors that influence the effectiveness of its use.
2. A journal by Sari & Nugroho (2022) revealed that the use of information and communication technology (ICT) in learning is influenced by supporting and inhibiting factors. Supporting factors include technical support such as the availability of projectors, LCDs, and loudspeakers in each classroom, as well as full support from the school and principal. Furthermore, teacher competence in using technology is also a crucial aspect in accordance with pedagogical competency standards (Adz Dzaky et al., 2020). However, there are obstacles such as device damage that requires a long time to repair and teachers' busy schedules that reduce the time needed to prepare more optimal learning media.
3. Smith et al.'s (2020) journal showed that prospective teachers had high self-efficacy in online communication, with an average perceived readiness score of 3.34, reflecting their competence in delivering material effectively during online discussions. This readiness was developed through various activities such as presentations, teaching practices, and demonstration teaching. The prospective teachers also demonstrated high motivation,

openness to new ideas, willingness to share, and adaptability to online learning. These findings align with previous research that suggests teachers are ready to integrate technology into their learning. This readiness is crucial in navigating the shift from traditional to online learning, which demands technical skills and adaptation to virtual environments.

4. Nuraini's journal (2023) emphasizes the importance of ICT literacy as part of the 21st-century skills that society must possess, including in the world of education. Students who are familiar with technology encourage teachers and schools to integrate technology into learning through the TPACK approach, which is a combination of technological, pedagogical, and content knowledge. The use of technology in learning requires not only access and skills but also the ability to design effective learning. At the Indonesian School of Kuala Lumpur (SIKL), the TPACK approach is implemented through the Blended Learning model, even though learning is already taking place face-to-face. Teachers continue to utilize platforms such as Google Classroom, Quizziz, and others to reduce physical contact. Within the TPACK framework, the pedagogical aspect is also very important because it includes a deep understanding of students and planning appropriate teaching strategies.
5. Rahmawati's (2023) journal shows that the development program at SDN Waringin Leuwiliang Bogor focuses on improving teachers' pedagogical, social, and personal competencies. Activities such as workshops, training, MGMPs, and teacher learning communities encourage collaboration and professional development. MGMPs play a strategic role as a forum for sharing experiences and learning solutions, while also strengthening the quality of teaching relevant to student needs and curriculum development.
6. Siti Sarah's journal (2024) concluded that technology-based learning can significantly increase student motivation. The use of multimedia, e-learning, game-based learning, and flipped classrooms has been shown to make the learning process more interactive, engaging, and understandable. The successful implementation of this technology is greatly influenced by appropriate instructional design, the role of teachers, and adequate infrastructure. For maximum effectiveness, careful learning planning, clear objectives, appropriate learning strategies, and accurate evaluation of learning outcomes are required. Overall, learning technology not only increases student engagement but also positively impacts their academic achievement and skill development.
7. Adlin's (2019) journal indicates that the use of laptops or computers in learning depends heavily on the classroom situation and learning objectives. Technology, such as laptops and LCD projectors, is typically used to support presentation methods to make material more engaging and interactive. However, the success of learning remains determined by the teacher as the primary presenter. The use of ICT-based media must consider learning objectives, equipment availability, cost, and student characteristics and conditions. Furthermore, teachers also need to possess basic skills in operating computer hardware and software to ensure effective and efficient learning.
8. Lovandri et al.'s (2023) journal revealed that the school has provided various technological facilities such as LCD projectors, sound systems, tablets, laptops, and digital platforms like YouTube, Canva, Google Classroom, and Google Forms to support ICT-based learning. Teachers at the school are accustomed to using these technologies to deliver materials and assess student learning outcomes more efficiently. Furthermore, the Teacher Working Group (KKG) plays a crucial role as a platform for developing teacher professionalism in utilizing ICT, through various activities that help teachers overcome learning challenges and improve their technological skills.
9. Arsy et al.'s (2023) journal emphasized the importance of TPACK-based learning media for teachers to ensure optimal learning in line with current developments. Although technology-based media is available at Aisyiyah Elementary School, many teachers have not yet fully integrated TPACK competencies due to a lack of knowledge. Mastery of TPACK is expected to improve student learning outcomes and the quality of education. This study also shows that the learning media developed by teachers is good in terms of material that is in line with basic competencies, systematic and motivating learning designs, attractive and consistent media quality, and implementation power that facilitates use and encourages students to actively learn. All of these aspects show significant improvements, indicating progress in the development of TPACK-based learning media.
10. A journal by Dinda et al. (2023) explains that information technology plays a crucial role in supporting online learning at SMA Negeri 5 Surakarta, both as a supporting tool, in implementing learning, and in delivering information. Devices such as mobile phones, laptops, and computers are used to access learning via video conferencing and text-based materials, as well as to assist with assignment submission and discussions. The school also addresses signal constraints by tethering personal devices and adding Wi-Fi hotspots to ensure smooth

learning. This use of technology aligns with the role of educational technology in increasing efficiency, effectiveness, and achieving learning objectives. The availability of technological facilities and infrastructure is a crucial factor in the success of online learning at the school.

11. A journal by Adam et al. (2023) shows that teachers utilize technology and the internet effectively in learning by planning curriculum-aligned materials, using devices such as laptops, projectors, and smartphones, and accessing online learning resources like YouTube and Google. Teachers also utilize social media such as WhatsApp, Facebook, and Instagram to deliver materials and assignments, and communicate with students and parents. During learning, teachers actively monitor student concentration through questions and answers and short discussions. The use of the internet in learning increases students' independence in seeking information and broadening their horizons, while making the learning process more engaging and varied than manual methods.
12. A journal by Reksa et al. (2023) emphasized the importance of digital literacy for teachers in the 21st century, where teachers are required not only to master digital technology but also to be able to distinguish between true and false information. Teachers who are not technologically literate risk hindering their professionalism, as current learning is ICT-based with a 4C approach (Critical Thinking, Collaboration, Creativity, Communication). Digital literacy includes the ability to use hardware and supporting applications to design quality learning. For example, the Smart Class application enables online learning interactions between students and teachers, although its implementation at YPWKS Elementary School is still in its early stages. By mastering digital literacy, teachers can optimize both online and offline learning processes effectively.
13. A journal by Aah et al. (2022) shows that the use of digital devices in elementary school learning has become a new culture, with applications such as PowerPoint, Google Forms, YouTube, social media, and others widely used by teachers and students. PowerPoint remains dominant due to its perceived efficiency and ease of use, but teachers and students are beginning to shift to simpler and more practical applications such as social media. Although most teachers feel capable of using this technology, some are still not proficient, creating a gap between digital demands and teacher capabilities. Mastery of digital technology is crucial for teachers to support professionalism and the quality of learning.
14. A study by Rafi et al. (2024) shows that the use of technology in mathematics learning provides significant benefits, especially with software like GeoGebra, which helps visualize abstract concepts and supports discovery-based learning. Other studies also confirm the effectiveness of technology at various levels of education, including elementary schools, where the use of projectors can attract students' attention and satisfy their curiosity. Furthermore, Cabri Geometry II software has been shown to improve students' mathematical connection skills in geometry learning. Overall, digital technology plays a significant role in improving students' mathematics learning outcomes.
15. A journal by Fajar Dwi (2023) explains that artificial intelligence (AI) is a technology that enables computer systems to perform tasks that typically require human intelligence, such as decision-making and learning. In an educational context, AI can personalize learning by analyzing the needs and abilities of each student. For example, AI-based learning media such as puzzle makers can increase student active engagement in problem-solving and support collaborative learning. The use of AI in learning provides an adaptive learning experience tailored to individual abilities, thereby increasing student motivation, intelligence, discipline, and learning effectiveness.
16. A journal by Nur et al. (2024) emphasized that teachers play a key role in educational success by creating a conducive and creative learning environment to prevent students from getting bored. Educational technology plays a crucial role in supporting the learning process, such as designing knowledge, providing information, encouraging debate, increasing efficiency and effectiveness, and assisting students in decision-making. In elementary schools, the use of laptops and projectors integrated with video, audio, images, and PowerPoint media is highly effective in stimulating students' cognitive, affective, and psychomotor skills. PowerPoint, in particular, helps improve students' technological skills, facilitates understanding of the material, and increases enthusiasm and activeness in learning, making it an effective tool for creating engaging and interactive learning both face-to-face and online
17. A journal by Unik (2021) explains that information and communication technology (ICT) has brought significant changes to human life with various positive benefits, such as enriching interactions and facilitating easy access to information. However, ICT also has negative impacts, particularly in terms of morality, as it becomes a

medium for the spread of behavior that violates social and religious norms. In the context of learning, technology plays a crucial role in facilitating collaborative relationships between teachers, students, and learning resources through various communication applications such as Skype, Zoom, and Google Meet. Furthermore, technology provides a realistic and safe learning environment for solving complex problems and helps students actively construct meaning by accessing research, photos, and videos online, making learning more meaningful and easier to understand.

18. A journal by Juraedah et al. (2021) emphasizes the importance of teacher skills in using online learning applications to effectively manage the learning process, which positively impacts student learning outcomes. Skilled teachers can design online learning that is light and relevant to the material and utilizes appropriate online media. Furthermore, learning applications play a significant role in communication between teachers and students, which is crucial for achieving meaningful learning. Learning management systems like Google Classroom make it easier for teachers to deliver materials and manage classes online, especially during the Covid-19 pandemic. Therefore, training and development of information technology competencies for teachers are essential so they can keep up with technological developments and implement distance learning effectively.
19. A journal by Munawir (2021) highlights the importance of using technological media, particularly educational games and animations, in learning at Islamic Elementary Schools (Madrasah Ibtidaiyah) to make the learning process more engaging and increase student interest and absorption, particularly in science and religious subjects. For example, Augmented Reality technology is used to interactively introduce the Solar System. Furthermore, information technology literacy is not limited to the ability to access devices but also encompasses teachers' ability to creatively utilize technology to produce useful learning products. Teacher competency standards in ICT include computer operation, device maintenance, programming, word processing, spreadsheets, data management, and creating interactive presentations to support effective learning processes.
20. A journal by Hilmiyatul (2024) emphasized that the use of technology in the classroom is a crucial innovation that makes learning more engaging, personalized, and interactive, while enabling students to learn independently and collaborate without geographical boundaries. The role of teachers has also shifted to that of effective managers of learning resources and instruction by selecting media and adjusting the process based on evaluation. Learning technology is not only a tool but also a discipline that improves the overall quality of education. Although there are obstacles such as limited infrastructure, teacher skills, and costs, solutions such as increasing access, providing quality materials, and teacher training are essential to overcome these obstacles.

An analysis of these 20 articles reveals that the use of information and communication technology (ICT) in education has proven effective in increasing student motivation, engagement, and learning outcomes, particularly in online learning. Platforms such as Google Classroom, video conferencing, multimedia, and educational games are widely used by teachers to support the learning process. This success depends on teacher competence, particularly in digital literacy and mastery of the TPACK model. However, challenges remain, such as limited infrastructure, costs, and teacher skills, which need to be addressed through training and the provision of facilities. Technologies such as AI and augmented reality also contribute to enriching, more interactive and personalized learning. Overall, ICT is no longer merely a tool but a crucial part of the transformation of modern education, with teachers being the key to its success.

CONCLUSION

Based on a systematic literature review of 20 articles related to teachers' ability to utilize learning technology, it is known that the process of integrating technology into teaching and learning activities is influenced by several key factors. These factors include: (1) the availability of continuous professional training, (2) adequate institutional support and infrastructure, (3) teachers' level of confidence in using technology, and (4) teachers' attitudes and digital literacy skills. Teachers' mastery of the concept of Technological Pedagogical Content Knowledge (TPACK) continues to show disparities. While the majority of teachers have a good grasp of content and pedagogy, they still struggle to effectively integrate technology into their learning practices. This obstacle is compounded by limited facilities and infrastructure, a lack of context-appropriate training, and inadequate policy support from educational institutions. Overall, it can be concluded that the success of digitalization in education is largely determined by teacher competence, which needs to be supported by a supportive educational environment, relevant training, and policies that encourage the inclusive and sustainable use of technology.

SUGGESTION

1. The development of practical, locally relevant, and sustainable TPACK-based training programs is essential for the government and educational institutions to improve teachers' competency in implementing technology in the learning process.
2. The provision of information and communication technology (ICT) infrastructure in school environments, particularly in underdeveloped areas, must be a primary focus in efforts to digitize education to minimize access disparities.
3. Strengthening digital-based education policies is crucial to reward teachers who demonstrate innovation, provide consistent technical assistance, and ensure the implementation of technology across all levels of education and subject areas.
4. Facilitation of ongoing mentoring and the formation of a digital-based teacher community is needed as a forum for collaboration, knowledge sharing, and independent and continuous capacity building.
5. It is recommended that further research be conducted using an empirical approach at various levels and local educational contexts, in order to gain deeper insights into optimal strategies for integrating learning technology by educators.

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