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Effectiveness of Professional Teacher Education in Developing Educational Technology Skills in the Digital Era

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ABSTRAK

The transformation of digital technology has resulted in fundamental changes in various sectors of life, including the field of education which is experiencing a significant paradigm shift. This study aims to explore the effectiveness of teacher professional education in improving educational technology skills in the digital era. Along with the rapid development of technology, teachers' ability to integrate technology into the learning process becomes a key element in creating innovative and relevant learning experiences. This study uses a descriptive qualitative approach involving teachers who have participated in the professional education program as the main participants. Data were obtained through in-depth interviews, observations, and document analysis of the education programs followed by the teachers. The results show that professional education substantially improves teachers' skills in utilizing various technological tools, including learning software, digital platforms and technology-based teaching techniques. In addition, the program also encourages the development of positive attitudes towards the use of technology as an integral part of learning. However, the effectiveness of the program is inseparable from challenges such as limited access to technology facilities, lack of follow-up training, and differences in the level of individual readiness to adopt technology. This study concludes that systematically designed professional education with a focus on educational technology has great potential to strengthen teachers competencies in the digital era. These results provide important implications for policy makers and education providers to continue developing needs-based programs, providing adequate infrastructure, and creating a supportive ecosystem that supports the application of technology in learning.

INTRODUCTION

The transformation of digital technology has produced fundamental changes in various sectors of life, including the field of education which has experienced a significant paradigm shift. In the context of the digital era, technology no longer acts as a supporting instrument, but has become an essential component in revolutionizing the learning process (Makinde, 2024). The utilization of educational technologies, such as

artificial intelligence-based software, online learning platforms and cloud-based digital collaboration tools, creates new opportunities to improve the efficiency, interactivity and relevance of the learning process to the needs of the 21st century global society (Govea, 2023). The integration of these technologies enables a more flexible approach to learning through personalization of materials according to students' learning preferences and pace (Sumantri, 2024); (Yusuf, 2024). In addition, the development of cross-disciplinary and cross-cultural collaboration skills is facilitated through the use of digital tools, thus providing a holistic and future-oriented educational experience. However, the application of technology in education requires high pedagogical and technical competence from educators (Eliza, 2022). The ability to design, implement and evaluate technology-based learning strategies is an urgent need to ensure that technology is not only a tool, but also a catalyst for meaningful learning.

Teachers as the spearhead of the learning process face increasingly complex challenges in meeting the demands of education in the digital era. In many developing countries, in particular, teachers often face significant limitations in mastering educational technology (Rodriguez, 2022). One of the main causes of this gap is the lack of adequate training in the use of technology, which makes teachers feel underprepared to integrate technology into the teaching process. In addition, the lack of access to adequate technological tools, such as computers, projectors, and stable internet connections, is a major obstacle to the optimal utilization of technology (Haleem, 2022); (Marsevani, 2024). Schools in remote or less developed areas often do not have sufficient facilities to support the effective use of technology, so teachers are forced to rely on traditional methods that are less supportive of student development in the digital age (Mali, 2023). Without strong support from the school or government, such as budget allocations for ongoing training or procurement of technology devices, teachers struggle to acquire the necessary skills to meet the needs of increasingly technology-based learning. This condition has the potential to hinder teachers' ability to utilize technology optimally, which in turn has a negative impact on the effectiveness of learning in the classroom. Teachers who are not technology-ready will find it difficult to adapt learning materials, design interactive learning experiences and provide technology-based evaluations, which are increasingly important in modern education (Oladele, 2024).

Teacher professional education programs are initiatives designed to improve the quality of educators through the mastery of various skills, including educational technology (Mpuangnan, 2024); (Khairani, 2024). With the rapid development of digital technology, the need for teachers who are able to utilize technology in learning has become increasingly urgent. This program is designed to answer that challenge by providing practice-based training that is relevant to the needs of the times. Through this program, teachers are expected to be able to not only master technology, but also understand how to use it to create learning that is more interactive, interesting, and in line with the needs of 21st century students (Nasution, 2024). The training in this program covers various aspects of educational technology, from mastering learning software to implementing technology-based strategies in the classroom. Teachers are taught how to utilize online platforms for distance learning, use digital collaboration tools to increase student participation, and design engaging learning materials with the help of multimedia technology. With a practice-focused approach, the program provides not only theoretical understanding, but also hands-on experience for teachers in applying technology in learning. This is important to ensure that teachers feel confident and ready to apply what they have learned in the school environment.

Teacher professional education programs are designed to support the development of teachers' positive attitudes towards technology (Ahadi, 2024). Not all teachers have an optimistic view of technology some are hesitant or even reluctant to use it in teaching. Therefore, the program also includes training sessions aimed at changing teachers' perceptions of technology, so that they can see it as a tool that facilitates and enriches learning. The development of this positive attitude is important to ensure that technology is not just understood as an additional tool, but as an integral element in creating relevant and meaningful learning experiences. While teacher professional education programs have great potential, their effectiveness has not been fully measured and consistent across different contexts. Several challenges remain in the implementation of these programs, especially in terms of training design, which often does not match the specific needs of teachers. Training materials are sometimes too general and less relevant to real conditions in the field, making it difficult for teachers to apply in their teaching context. In addition, accessibility issues are also an obstacle, especially for teachers in remote areas who often find it difficult to attend training due to limited technological infrastructure such as stable internet connections and the availability of technological devices. The success of teacher professional education programs also depends on other factors, such as individual teacher motivation, support from educational institutions, and technological infrastructure readiness (Stumbriene, 2024). Teachers' motivation to attend training and implement technology in learning plays a key role in determining the effectiveness of teacher professional programs (Karim, 2024). On the other hand, educational institutions also need to provide adequate support, both in the form of policies, incentives, and technological facilities needed by teachers to implement the results of training. Thus, the success of this program is not only determined by the quality of the training, but also by the synergy between individuals, institutions and supporting infrastructure. If these challenges can be overcome, teacher professional education programs have great potential to create educators who are competent, adaptive, and ready to face the challenges of education in the digital era.

This study aims to explore the effectiveness of teacher professional education in developing educational technology skills in the digital era, focusing on the extent to which training programs are able to improve teachers' technological competencies. In addition to examining the positive impact of the training on teachers' ability to use technology, the study also sought to identify the constraints faced during implementation. Against this background, this study highlights the urgency of updating the teacher professional education system that is not only adaptive to technological change, but also oriented to the practical teaching needs faced by teachers in the field. Along with the rapid development of technology, the world of education must be able to respond quickly to ensure that educators have the necessary skills to utilize technology to support effective and relevant learning processes. Therefore, reforming the teacher professional education system must go beyond introducing new technologies to ensure that they can be optimally used in real teaching contexts. This systematic approach to training program delivery is a strategic step towards creating an inclusive, progressive and technology-based education ecosystem. A well-structured training system that includes practice-based learning, continuous mentoring and effective evaluation will ensure that teachers not only have a theoretical understanding of technology but are also able to practically integrate technology into teaching methodologies. Programs designed with this holistic approach will support the creation of more flexible learning environments, enable teachers to design more interactive and collaborative learning experiences, and provide more

engaging and meaningful experiences for students. Thus, this practical needs-oriented renewal of the teacher professional education system will not only improve the quality of teaching, but also prepare future generations to face the challenges of an increasingly digital and connected world.

METHODOLOGY

This study uses a descriptive qualitative approach to explore the effectiveness of teacher professional education in improving educational technology skills in the digital era. This approach was chosen because it can provide an in-depth understanding of the experiences, perceptions and challenges faced by teachers during the professional education program. The research was conducted in several educational institutions and teacher training institutions that have conducted intensive educational technology training programs. The research subjects were teachers who had participated in professional education programs in the past year. The purposive sampling technique was used to select participants with certain criteria, such as teachers who are actively teaching at the primary or secondary education level, have completed training related to educational technology, and are willing to participate voluntarily. The selection of participants was done to ensure that the data obtained was relevant to the research objectives.

Data collection was conducted through three main methods. First, in-depth interviews were used to explore teachers' experiences and perceptions regarding the effectiveness of the professional education program. The interviews were designed using a guide that covered themes such as the relevance of training materials, the quality of teaching methods and the impact of training on technology skills applied in the classroom. Second, participant observation was conducted to see firsthand how teachers apply the educational technology skills acquired during the training. These observations are conducted in the context of the classroom to understand the extent to which the training outcomes can be implemented in daily teaching practices. Observation data provides an additional perspective that complements the information from the interviews. Third, documentation was used as an additional data source. The documents analyzed included training modules, program activity reports, and participant evaluation results. Document analysis aims to understand the design, structure, and objectives of the training, as well as to evaluate the suitability of the program to the participants' needs. The collected data were analyzed using thematic analysis techniques. The analysis process began with data reduction to filter out information relevant to the research focus. Next, the data was grouped into main themes, such as the effectiveness of the training materials, implementation constraints and success factors. The final stage was data interpretation, where the findings were linked to relevant theories and literature to develop a comprehensive narrative.

RESULTS AND DISCUSSION

This study shows that the teacher professional education program has a significant impact on improving educational technology skills. Based on the interview results, the majority of teachers reported a development in their understanding and skills in utilizing technology to support the learning process. They feel more confident in using learning software, video conferencing applications and online classroom management platforms such as Learning Management System (LMS). The teacher professional program equips teachers with the ability to integrate technology effectively in lesson delivery, assignment creation and learning evaluation. This facilitates teachers to create more innovative

learning that is responsive to the needs of 21st century students. Technology can serve as a tool to support active learning experiences, where students are directly involved in the learning process through interaction with digital media (Baroroh, 2024). This provides room for teachers to develop teaching strategies that are experiential and collaborative, so as to improve student learning outcomes. The success of technology adoption in education is influenced by perceptions of ease, benefits, and suitability of technology to user needs (Sundari, 2024). With comprehensive training, teachers are able to see the real benefits of technology as a tool to improve teaching quality, thus promoting a more inclusive and sustainable transformation of education.

Observations in the field show significant changes in the way teachers manage learning after attending the teacher professional education program. Teachers who have received this training show a better ability to create a creative and innovative learning atmosphere. Teachers focus not only on delivering materials but also on developing interactive and collaborative learning methods (Basikin, 2023). This training encourages teachers to explore new approaches that attract students' interest and activate their participation in the learning process. One of the most striking changes is how technology is now strategically used as the main medium of learning. Teachers no longer see technology as an additional tool but as an integral component of the teaching-learning process. The use of technology allows teachers to design more dynamic learning experiences (Clark, 2020). For example, some teachers create interactive learning videos that engage students in the process of understanding the material directly. These videos are designed with elements that attract students' attention, so they are more emotionally and intellectually engaged.

Teachers also utilize technology to improve the effectiveness of learning evaluation. Online quiz platforms, used to conduct real-time evaluation, provide immediate feedback to students. This feedback is very useful to improve students' understanding of the material that is less mastered. In addition, simulation-based applications are used to explain abstract concepts that are difficult to understand through conventional methods. With the help of simulations, students can interact directly with the material, which makes learning more real and in-depth. The use of technology in learning is proven to significantly increase students' interest in learning (Ardita, 2024). A varied and fun approach makes students feel more interested in actively participating in learning. Technology also allows teachers to reach various learning styles of students in the classroom (Zhang, 2024). For example, students who are more visually responsive can benefit from learning videos, while students who prefer interactive learning can utilize simulations or online quiz platforms. In this way, learning becomes more inclusive and responsive to students' diverse learning needs. The application of technology not only increases student engagement in learning, but also strengthens learning outcomes (Situmorang, 2024). Teachers can provide tools and methods tailored to students' individual needs, thus creating a more inclusive learning space. With a more personalized approach, students feel valued and motivated to learn. The effectiveness of classroom learning increases as students have better access to resources that support their understanding. Ultimately, technology becomes an important pillar in realizing a more meaningful and quality learning process.

The study also revealed a number of constraints in the application of the educational technology skills acquired during the training. One of the main constraints found was the limited infrastructure in schools, especially in remote and less developed areas (Oubibi, 2024). Teachers reported that the lack of adequate hardware, such as computers,

projectors and internet devices, is a major hindrance in making the most of technology to support the learning process. Teachers also face difficulties with unstable internet connection, which is often a big challenge in implementing online learning or using cloud-based applications. Teachers revealed that this constraint affects their ability to run the class effectively, especially when relying on technology to access learning materials or conduct online evaluation. Limited access to devices and good connections also exacerbate the gap between schools that are well-equipped and those that lack technological facilities, creating a disparity in the quality of education that can be provided (Azri, 2024). These constraints point to the need for a significant increase in investment in education technology infrastructure in schools, especially in areas that still lack access to technology. With improvements in this aspect, teachers will be able to fully utilize the potential of technology to improve the quality of learning and create a more equitable and inclusive learning experience for all students.

Institutional support also plays a very important role in the successful implementation of educational technology training outcomes (Munir, 2024). Teachers who work in schools with a strong culture of innovation report ease in adopting educational technology because they feel actively supported by the institutions where they work. This support includes various aspects, such as the provision of adequate technology tools, budget allocation for further training and the establishment of a learning community among teachers that allows them to share experiences and knowledge. When principals are committed to creating an environment that supports the use of technology, it makes it easier for teachers to implement the skills they gain from training more effectively (Chiu, 2024). In addition, the existence of clear and structured policies regarding the integration of technology into the curriculum also helps accelerate the adoption of technology in the classroom. Conversely, a lack of support from the institution, especially the principal's passive attitude towards innovation or the absence of policies that support technology integration, can cause significant barriers. Teachers who do not receive adequate support often find it difficult to implement training outcomes, as they do not have sufficient access to the necessary technological tools or there is no space for them to experiment with new ways of teaching. In some cases, a lack of institutional commitment to teacher professional development and technology adoption can also discourage and motivate teachers to implement changes in their learning processes. Therefore, it is important for the school, especially the principal, to provide continuous support and develop policies that support technology integration, in order to create a conducive environment for teachers to continue to develop and innovate in optimizing educational technology.

Teacher professional education programs provide significant benefits in developing educational technology skills, which in turn contribute to improving the quality of learning (Smith, 2023); (Chang, 2024). The program not only provides teachers with practical skills in using various technological tools, but also increases understanding of how to integrate technology into a more effective teaching process. However, the success of this program is greatly influenced by several important factors that must be considered comprehensively. One of the main factors is adequate technology infrastructure. Without hardware support and a good internet connection, the implementation of educational technology will be hampered, even if teachers have sufficient skills. In addition, institutional support, especially from school principals and policy makers at the education level, also plays a crucial role. Schools that have a strong culture of innovation, as well as policies that support technology integration, tend to have higher success rates (Akrima,

2024). Another important factor is training time. The limited time allocation often prevents teachers from exploring the material to the fullest, so that technology-based learning becomes less optimal. The relevance of training materials also determines their effectiveness, as materials that are not tailored to local needs or real conditions in the field will be difficult to apply in the real learning context.

CONCLUSION

Based on the results of the study, it can be concluded that teacher professional education programs have a significant impact in improving educational technology skills in the digital era. Teachers who attended the training program showed improvement in their understanding and ability to use technology to support learning, such as the use of learning software, video conferencing applications and online classroom management platforms. The application of these technologies helps create more interactive, collaborative and engaging learning for students. The effectiveness of this training program is not only influenced by the materials and methods taught, but also by external factors such as limited technology infrastructure, especially in remote areas, and support from educational institutions. Constraints in access to technological devices and unstable internet connections are the main obstacles in applying the skills acquired. Overall, the results of this study show that while the teacher professional education program has had a positive impact on developing educational technology skills, there is a need for improvement in terms of infrastructure, time allocation and institutional support to maximize the success of the training.

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