Enhancing Early Childhood Educator's Digital Competencies through AI-Powered Learning Modules (AI-PEL) Training Program

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Abstract

Purpose – Digital skills among educators are becoming increasingly important and essential for creating interactive and relevant learning experiences. However, many teachers are still unprepared to fully integrate technology into their teaching and need to improve their understanding of AI technology to support the learning process. This study aims to determine the effectiveness of improving the digital skills of early childhood education (ECE) teachers through AI-Powered Learning Modules (AI-PEL) training.

Design/methods/approach – This research employs a quantitative approach with a quasi-experimental method to evaluate the effectiveness of AI-Powered Learning Modules (AI-PEL) training for Early Childhood Education (ECE) teachers in the Tumpang Sub-district. Purposive sampling was used to select 80 ECE teachers who participated in the training. Data were collected through pre-tests and post-tests. Data analysis involved descriptive statistics using SPSS 17.0, including the Kolmogorov-Smirnov test for normality, Cronbach's Alpha for reliability, and Independent t-tests to compare group means.

Findings – This study found a significant improvement in the digital skills of ECE teachers in the Tumpang Sub-district after the AI-PEL training. Initially, the teachers struggled with technology integration, but after the training, their skills and understanding of digital tools improved. Evidence shows that 68 out of 80 participants successfully created teaching modules and picture stories using AI technologies such as Chat GPT, Gemini, DeepL, and Bing Image Creator within the specified deadline.

Research implications/limitations – This finding highlights the importance of improving digital skills among teachers, as it enhances their teaching effectiveness and positively impacts students' learning experiences and outcomes. This fosters an engaging, interactive, and effective learning environment in the 21st century.

Practical implications – This research emphasizes the importance of supporting strategies such as developing digital learning modules, continuous mentoring, and integrating technology into the ECE curriculum. Partnerships with stakeholders are also crucial to ensuring the sustainability and effectiveness of the AI-Powered Learning Modules (AI-PEL) Training Program. These measures are essential for improving teachers' digital skills and the overall quality of teacher education in the 21st century.

Originality/value – This research highlights that early childhood teachers can develop more creative and effective teaching methods with good digital skills. Ultimately, this will improve the quality of early childhood education for the 21st century.

Keywords AI-PEL, Digital skills, Early childhood education, Teacher training

Paper type Research paper

1. Introduction

Digital Skills among educators is becoming increasingly important in the current technological era, as the ability to use information and communication technologies effectively is key to creating interactive and relevant learning (Muntu et al., 2023). Positive attitudes towards technology and its perceived usefulness significantly influence teachers' technology adoption, ultimately shaping the effectiveness of digital Skills integration in education. For educators, digital Skills provides great benefits, such as increasing the interactivity and efficiency of learning and enabling collaboration with peers and education experts so that teachers are better equipped to prepare successful students in the digital era (Sudarti et al., 2020).

Based on 2018 UNESCO data showing that 60% of teachers in developing countries feel they lack adequate digital skills and data from the Information and Communication Technology Center (Pustekkom) of the Ministry of Education and Culture (Kemdikbud) showing that only 40% of teachers outside the Technology and Communication (ICT) field have mastered digital technology in learning, proving that there is an urgent need to address digital Skills competencies among educators (Ria & Wahidy, 2020). Most teachers are not fully prepared to integrate technology into their learning, especially in developing countries like Indonesia. This is because 80% of teachers have limited access to the internet and technology devices, 70% of teachers lack training and mentoring, and 60% of teachers have concerns about data security and privacy (Verawadina et al., 2019). This can limit the potential for interactive and relevant learning that can be presented to students.

This problem is specific to Malang District, particularly in Tumpang Sub-district, where less than half of 171 Early Childhood Education (ECE) teachers have basic digital technology skills. Based on observations, most ECE teachers in the Tumpang sub-district are middle-aged and have limited skills in mastering Information and Communication Technology (ICT). Many teachers are not up to date with the development of artificial intelligence (AI) technology that can be applied in the learning process. This reflects a need for more adequate skills and knowledge regarding AI and its application in learning contexts.

In addition, the need for more training and support for teachers in adopting AI for learning, their fear and hesitation in trying new technologies, and the need for pedagogical adaptations and learning methods to effectively integrate AI are problems encountered. This problem is influenced by the inequality of training and socialization programs on using AI in learning (Nurjannah, 2022). As a result, many ECE teachers in the Tumpang area use conventional learning methods with minimal application of digital Skills. A lack of understanding of AI technology among teachers can result in low student engagement and a decrease in the overall quality of education.

Poor mastery of digital Skills certainly impacts the quality of early childhood learning (Hidayatullah et al., 2021). Teachers who are not skilled in digital Skills will find it difficult to use modern technology to make learning more interactive, engaging and relevant for students (Bećirović, 2023). This can hinder an adequate learning experience, which should involve the use of digital tools to facilitate the understanding of the concepts and skills being taught. The tendency of conventional forms of learning and the reluctance to learn digital Skills in an effort to assist in learning causes early childhood to have difficulty recognizing modern devices, modern learning, potentially experiencing boredom which results in obstructed knowledge transfer (Irwanto & Irwansyah, 2020).

Yafie et al. (2020) emphasize the importance of implementing training programs for teachers to improve competence through critical thinking skills and improve the teaching-learning process. Research conducted by Atmojo et al. (2022) also emphasized the importance of teachers having digital Skills skills to teach students about digital technology and online behaviour. This confirms that various digital skills are needed for effective teaching in the digital era. Similarly, as Ovcharuk and Ivaniuk (2021) highlighted, continuous professional development is necessary to improve teachers' digital skills and promote lifelong education.

Based on these conditions, to improve digital Skills among teachers, including AI technology skills training, there is a need for training related to using digital technology that utilizes AI, such as AI-Powered Learning Modules (AI-PEL) training. AI-PEL was chosen as an appropriate solution because it leverages AI technology to provide a personalized and adaptive learning experience which can adjust to each teacher's individual needs and abilities. Specialized training was deemed necessary to improve ECE teachers' skills in this area, as their current level of proficiency is moderate (Yafie et al., 2018). In addition, the potential application of AI-based learning in ECE settings may allow for integration into early childhood education (Jayawardana & Sugiarto, 2023).

Training programs focusing on digital Skills and using digital technologies are essential for teachers to access, manage information, and integrate it into their teaching content (Falloon, 2020). Research by Alamin et al. (2023) shows the positive impact of training programs that focus on interactive educational applications for early childhood teachers in improving competence and quality of learning at the early childhood level. Ayanwale et al. (2024) state that integrating AI into teacher training programs can significantly improve teaching and learning outcomes by providing new tools and resources for educators.

AI-PEL training must be implemented to help teachers adapt teaching practices to advances in science, technology, and communication in the 21st century. Through AI-PEL training, teachers can more quickly master the digital skills needed, making it a very suitable solution to effectively improve digital Skills and create and produce AI-based learning modules that are interesting, interactive, and, of course, fun. Based on the problems and solutions offered above, this study aims to measure the effectiveness of improving the digital Skills of early childhood education (ECE) teachers through AI-Powered Learning Modules (AI-PEL) training.

2. Methods

2.1. Research Design

This research uses a quantitative approach with a quasi-experimental method. The quasi-experiment method was chosen because this research was conducted without randomization but involved placing participants into groups or providing Treatment to the group under study. The Treatment was conducted by observing the results of the AI-Powered Learning Modules (AI-PEL) Training. Figure 1 below show the research design of this research.
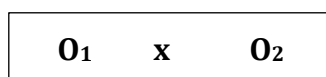
$$O_1 \quad x \quad O_2$$

Figure 1. Research Design

Description:
O1   = Pre-test before being given AI-PEL training
x   = Treatment at the time of training
O2   = Post-test after being given AI-PEL training

2.2. Population and Sample

In this study, the sampling method used was purposive sampling, which was chosen to accommodate the specific characteristics of the population under study. The population of ECE teachers in the Tumpang Sub-district was selected based on predetermined criteria, namely their participation in the AI-PEL training. Thus, the sample consisted of 80 ECE teachers who actively participated in the training as a relevant representation to illustrate the impact and effectiveness of this training program.

2.3. Data Collection Techniques

The data collection process in this study was conducted during the implementation of AI-PEL training for ECE teachers in the Tumpang Sub-district. The activity was conducted by giving pre-test before and post-test after the AI-PEL training. The items contained in the pretest and post-test were related to: 1) Introduction to AI and Interactive Applications in Learning; 2) Utilization of ChatGPT, Gemini.bard and Bing Image Creator will create learning materials; 3) Optimize

functions and tools in Canva for making materials and editing learning videos; and 4) Utilize wizer.me to create interactive worksheets in learning.

2.4. Data Analysis Techniques

In this study, Descriptive data analysis was employed to summarize and present the characteristics of the variables under investigation using the SPSS 17.0 program. The statistical techniques applied included: 1) the Kolmogorov-Smirnov test, utilized to assess the normality of the data distributions; 2) Cronbach's Alpha coefficient to evaluate the internal consistency reliability of measurement scales used in the study; and 3) Independent t-test was conducted to compare the means of two independent groups on a continuous outcome variable.

3. Result

3.1. Results of Validity and Reliability Test

Table 1 shows the validity and reliability test results. It displays the r table value and r count from the measurement using Kolmogorov Smirnov for the validity and Cronbach's alpha values for the reliability tests.

Table 1. Results of Validity and Reliability Test.

Dimension	r count	r table	Description	Cronbach's Alpha	Description
Introduction to AI and Interactive Applications in Learning	0.873	0.3	Valid		
	0.736	0.3	Valid		
	0.883	0.3	Valid		
	0.787	0.3	Valid		
	0.799	0.3	Valid		
Utilization of ChatGPT, Gemini.bard and Bing Image Creator will create learning materials	0,834	0.3	Valid		
	0.822	0.3	Valid		
	0.815	0.3	Valid		
	0.857	0.3	Valid		
	0.793	0.3	Valid	0.907	Reliabel
	0.778	0.3	Valid		
Optimize functions and tools in Canva for making materials and editing learning videos	0.783	0.3	Valid		
	0.893	0.3	Valid		
	0.935	0.3	Valid		
	0.865	0.3	Valid		
	0.784	0.3	Valid		
Utilize wizer.me to create interactive worksheets in learning	0.832	0.3	Valid		
	0.874	0.3	Valid		
	0.791	0.3	Valid		
	0.873	0.3	Valid		

Based on the validity and reliability test results in Table 1, the r-table value is 0.3. Indicators are declared valid if the r count value is greater than r table value. In the test results above, for each dimension tested, all indicators have an r count value more significant than the r table value of 0.3, so it can be interpreted that all indicators are valid. Meanwhile, variables are considered reliable for reliability testing if the Cronbach Alpha value is more significant than 0.60. In the test results above, the variables are declared reliable. They have an overall Cronbach Alpha value of 0.907, which indicates that the instruments used in this study are highly trustworthy because they are above 0.60.

3.2. Results of Indipendent T-Test

Table 2 depicts the results of the independent sample T-Test on the AI-PEL training pre-test and post-test data. It displays the mean and standard deviation of each pre-test and post-test, gain, t-count, and sig value.

The data on table 2. shows a significant increase in the dimensions of 'Introduction to AI and Interactive Applications in Learning' (20.25), 'Utilization of ChatGPT, Gemini.bard, and Bing Image Creator' (25.75), 'Optimization of functions and tools in Canva' (21.5), and 'Utilization of wizer.me'

(25.5). The t-count values for each dimension, specifically 3.365, 4.211, 3.348, and 3.213, all exceed 3 with a sig. 0.000. The sig value is <0.05, indicating a statistically significant improvement. These results underscore the effectiveness of the AI-PEL training program in enhancing digital Skills skills, making it a valuable tool for educators and researchers.

Table 2. Results of Indipendent T-Test

Dimension	Pre-test Mean	Standard Deviation	Post-test Mean	Standard Deviation	Gain	t-count	sig
Introduction to AI and Interactive Applications in Learning	60.25	19.61	80.5	17.57	20.25	3.465	0.000
Utilization of ChatGPT, Gemini.bard and Bing Image Creator will create learning materials	58.75	19.45	84.5	9.90	25.75	4.211	0.000
Optimize functions and tools in Canva for making materials and editing learning videos	63.25	20.32	84.75	13.58	21.5	3.348	0.000
Utilize wizer.me to create interactive worksheets in learning	52.75	21.01	78.25	16.10	25.5	3.213	0.000

4. Discussion

4.1. Effectiveness of Improving Digital Skills of ECE Teachers through AI-Powered Learning Modules (AI-PEL) Training

Based on the results of training activities and data testing, there is a significant increase in the digital Skills of ECE teachers in Tumpang District before and after training. This is in line with research (Anisa et al., 2023), which shows that improving academic qualifications through training can improve the Skills of educators, including ECE teachers. Before the training, most teachers faced difficulties operating and integrating technological devices into the learning process. After the AI-PEL training, there was a noticeable improvement in teachers' understanding and skills in using digital technology. This is evidenced by most participants successfully creating teaching modules and picture stories using AI technologies such as Chat GPT, Gemini, DeepL, and Bing Image Creator. Teachers previously less familiar with technology can now utilize various digital tools and platforms to support teaching and learning activities. Research Akbara (2022) also showed measurable improvements in digital Skills, suggesting that targeted training can effectively improve educators' digital skills.

Within the scope of early childhood education, digital Skills is a very important competency for teachers. In today's rapidly evolving educational landscape, improving teachers' digital Skills is not just a goal, but a necessity. Various strategies have been proposed to achieve this goal (Rahmawati et al., 2024), and the rapid development of technology and its widespread use in the learning process makes digital Skills even more important. The use of technology, such as AI, in educational settings has been shown to appeal to preschoolers and provide positive learning outcomes (Yang et al., 2022). Digital Skills allows teachers to effectively integrate technology into the curriculum, creating a more interactive and engaging learning experience for children. The significant improvement in digital Skills among ECE teachers in the Tumpang sub-district can be attributed to several factors. First, the structured and comprehensive training program provided teachers with the necessary skills and knowledge to navigate the digital landscape effectively.

This aligns with the notion that digital Skills is essential for teachers to use digital technology to acquire, process, manage, and evaluate digital information and resources (Rahmawati et al., 2024). A second factor is that the hands-on approach and practical sessions in the training facilitate experiential learning, allowing teachers to apply their newly acquired skills in real classrooms (Didi, 2024). These findings have important implications for educational practice in the same context. Improving digital Skills among teachers not only improves their teaching effectiveness but also has a positive impact on students' learning experiences and outcomes. According to Soekamto et al. (2022), teachers' level of digital Skills not only affects the integration of digital learning but also impacts students' digital skills. Digital Skills is not only a tool to access information but also a key factor in improving students' enthusiasm and learning achievement.

Developing digital Skills practices in schools aims to increase students' participation in digital media early on, fostering active, creative, productive and innovative individuals. This underscores the importance of integrating digital Skills into education to prepare students for the digital world. The need for digital Skills training for teachers' professional development has been emphasized in previous research, highlighting its importance in improving teaching practices. With the increasing integration of digital technologies in education, equipping teachers with adequate digital skills is crucial to fostering an engaging and effective learning environment.

Therefore, developing digital Skills for teachers is essential for sustainable development, and it requires diverse curricula, content, methods, and resources for practical training (Karlberg & Bezzina, 2022). The training program's success in the Tumpang sub-district underscores the importance of providing continuous professional development opportunities for teachers. The guidance and support provided during the training have increased early childhood education teachers' confidence in integrating technological innovations into their classrooms, promoting a more modern and adaptive learning environment.

Policymakers and education administrators should consider implementing similar training programs in other areas to bridge the digital Skills gap and promote equitable access to quality education. With the guidance and support provided during the training, ECE teachers in the Tumpang sub-district feel more prepared and confident in adopting technological innovations in their classrooms. This is important in creating a more modern and adaptive learning environment.

4.2. Strategies to Improve ECE Teachers' Digital Skills through Continuous AI-Powered Learning Modules (AI-PEL) Training

Improving the digital Skills of Early Childhood Education (ECE) teachers is essential to prepare children for the digital era. One promising approach to enhancing teachers' digital Skills is through AI-Powered Learning Modules (AI-PEL) training. This innovative training method, backed by research, can bridge the gap between children's digital play practices and teachers' ability to integrate digital technologies into the curriculum (Marsh et al., 2019). By instilling trust in AI-powered educational technologies, we can empower teachers to confidently utilize AI in the classroom, thereby preparing our children for the digital future (Nazaretsky et al., 2022).

Digital Skills, as proposed by Eshet-Alkalai in Didi (2024), is an essential survival skill for teachers in the digital era, which includes the ability to effectively utilize digital technology, solve educational problems, and innovate in teaching activities. Media Skills competencies among early childhood teachers play an essential role in understanding media concepts, integrating them into the curriculum, and implementing relevant school programs (Hasibuan et al., 2024). Digital Skills in early childhood education can foster cognitive development by stimulating curiosity and creativity in children. Strategies such as using learning videos and social media engagement can improve digital Skills in ECE, which positively impacts early childhood development (Rohandi et al., 2023). In addition, using digital stories in early childhood education helps develop children's digital Skills skills, which are fundamental to their future education (Purnama et al., 2022).

Pursuing improved digital Skills skills through continuous AI-PEL training involves several strategic approaches. First, the development of digital-based learning modules is essential. These modules must be further developed to create an adaptive and personalized learning experience.

Interactive training content such as videos, simulations, and gamification elements can significantly increase participant engagement and facilitate understanding of the material (Galdames-Calderón, 2023). The module is expected to have an automatic evaluation system to provide real-time feedback that allows teachers to identify areas for improvement and adjust their learning approach as needed (Duong et al., 2018).

Continuous training through regular workshops and webinars is equally crucial. These initiatives ensure that teachers are consistently equipped with the latest technological knowledge and best practices in digital education. By fostering learning communities, we can encourage teachers to share experiences, exchange ideas, and support each other in their journey to improve digital Skills (Garzón-Artacho et al., 2021). This collaborative approach can significantly enhance teachers' ability to utilize technology for effective teaching and learning, ultimately improving student learning outcomes (Yafie et al., 2022).

Moreover, integrating technology into the Early Childhood Education (ECE) curriculum is pivotal. Teachers play a critical role in influencing how students engage with technology, highlighting the importance of purposeful technology integration in educational settings (Nguyen & Habók, 2022). Technology must be integrated into the daily ECE curriculum for digital Skills training to have a real impact. Collaborative projects involving children using technology under teacher supervision can be a meaningful method of providing hands-on experience and developing early digital skills (Gjelaj et al., 2020). By providing support for teachers, promoting purposeful technology integration and emphasizing comprehensive digital skills development, children can benefit from enhanced learning experiences and early exposure to digital Skills.

Lastly, collaboration with various stakeholders is critical to the continued success of AI-PEL training programs. Educational institutions, technology companies, and governments are essential in providing resources, policy support, access to current technologies, funding, and additional training opportunities (Jia & Huang, 2023). This approach aligns with recommendations to integrate digital components into the curriculum to improve teachers' digital Skills (Nguyen & Habók, 2022). Partnerships with these parties can open access to various aspects such as technology tools, funding, and supporting infrastructure, allowing training to be carried out continuously and significantly impacting the quality of ECE education in the digital era.

The continuous integration of AI-Powered Learning Modules (AI-PEL) and professional development opportunities are essential to improve ECE teachers' digital Skills. ECE teachers can not only improve their digital Skills skills but also positively impact the learning process in the classroom. Digitally literate teachers will be more creative and innovative in their teaching, thus increasing children's interest and participation in learning. By equipping teachers with the necessary skills and knowledge, teachers will be better prepared to face the digital challenges of the digital age and provide better education for future generations.

5. Conclusion

Based on the study findings, the AI-Powered Learning Modules (AI-PEL) training significantly enhanced the digital skills of Early Childhood Education (ECE) teachers in the Tumpang District. This improvement is evidenced by their increased understanding of AI technology's applications in education and their enhanced proficiency in utilizing digital tools effectively. These advancements strengthen teachers' technical skills and elevate the overall quality of education provided to young learners. With improved digital literacy, ECE teachers are better equipped to innovate and employ more engaging and effective teaching methods, enhancing early childhood education quality. For future research, it would be valuable to explore the long-term effects of AI-PEL training on teachers' digital skills and its sustained impact on student learning outcomes over extended periods. Additionally, investigating the scalability of AI-powered educational interventions across diverse educational contexts could provide insights into optimizing training strategies for different settings. Understanding the specific challenges teachers face in integrating AI and digital technologies into daily classroom practices would also be beneficial for developing targeted support mechanisms. Longitudinal studies tracking the professional development of

teachers who undergo AI-PEL training could further elucidate the evolving nature of digital skills in educational settings and inform continuous improvement efforts.

Declarations

Author contribution statement

Evania Yafie conceived the idea, conducted data collection, and performed the analysis. Nur Anisa and Rosyi Damayani Twinsari Maningtyas developed the theory of AI-powered learning modules. Tomas Iriyanto, Nurul Farhana Jumaat developed the theory of digital skills. Rina Mukti Widiasih developed the theory of early childhood education. All authors engaged in discussions regarding the findings and made contributions to the final manuscript.

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Data availability statement

The dataset generated and analyzed during the research is available from the corresponding author upon reasonable request.

Declaration of interests statement

All authors declare that they have no financial or personal interests that could influence the work presented in this manuscript.

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