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Analysis of Early Childhood Education Teacher Training Needs in the Utilisation of Artificial Intelligence-Based Applications

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Abstract

Educational transformation in the Society 5.0 era positions artificial intelligence (AI) as a strategic technology with the potential to improve the quality of learning, including in early childhood education (PAUD). However, the implementation of AI in PAUD units remains suboptimal due to limited teacher competence, attitudes towards technology, and institutional support. This study aims to analyse the training needs of PAUD teachers in the use of AI-based applications by examining the influence of teachers' digital competence, openness to technology, access to infrastructure, and institutional support on these needs. The study used a quantitative explanatory approach with purposive sampling to examine 150 non-formal PAUD teachers in the Arcamanik District, Bandung City. Data were collected using a standardised questionnaire that had been tested for validity and reliability, and were then analysed using multiple linear regression. The results showed that all four variables simultaneously had a significant effect on PAUD teacher training needs, with an Adjusted R^2 value of 0.659. In part, openness towards technology and teachers' digital competence were the most dominant predictors. These findings emphasise the importance of designing PAUD teacher training programs that are comprehensive, sustainable, and aligned with institutional policies that are adaptive to the development of AI-based technologies.

Keywords: Artificial Intelligence; Teacher Training; Early Childhood Education; Digital Competence; Society 5.0.

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Introduction

The socio-technological transformation under the umbrella of the concept of Society 5.0 marks an important shift: technology is no longer positioned merely as an efficiency tool, but as a knowledge infrastructure that can change the way humans learn, work, and make decisions (Martynov et al., 2019; Tavares et al., 2022; Ziatdinov et al., 2024). In this landscape, artificial intelligence has become a general-purpose technology that has penetrated various industrial sectors, public services, the digital economy, and even education, with impacts that are not only operational but also epistemic, namely, how knowledge is produced, personalised, and distributed (Lu, 2019; Osetskyi et al., 2020; Susar & Aquaro, 2019; Yadav & Shrawankar, 2025).

In education, AI is often projected as a lever for more adaptive learning through personalisation, automated feedback, learning analytics support, and increased administrative efficiency. These developments overlap with demands for relevant, effective learning that is oriented toward developing individual potential (Darling-Hammond et al., 2020; Petrychenko et al., 2023). Several studies confirm that AI can provide a more targeted learning experience that is responsive to students' needs (Castro et al., 2024; Strielkowski et al., 2025; Xu, 2024). However, this narrative of opportunity does not automatically translate into meaningful practice; the adoption of educational technology is always shaped by teacher competence, school organisational culture, and infrastructure availability.

In the context of early childhood education (ECE), the issue of AI integration becomes more complex. ECE emphasises child-centred learning experiences, play, social interaction, and socio-emotional development. Therefore, the use of AI should not be understood simply as "application use," but rather as a pedagogical decision: when to use technology, for what purpose, and how to maintain the quality of human interaction that is central to early childhood learning. The literature shows that AI can help children understand basic computing and robotics concepts and support the development of creativity, emotional regulation, collaboration, literacy, and computational thinking (Su & Yang, 2022). Other studies also highlight the potential of AI to improve the quality of early childhood education by providing

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customised learning materials and experiences (Ulfa & Hina, 2025), as well as the contribution of AI literacy to active learning interventions (Solichah et al., 2024).

However, the use of AI in learning practices is often not yet mainstream. Many educators are still at the basic technology stage (e.g., presentations), so the gap between AI's potential and the reality of implementation remains wide (Ismail et al., 2024; Pham & Sampson, 2022; Selwyn, 2024; Svoboda, 2024). Recurring obstacles are also consistent: limited infrastructure, inadequate teacher digital literacy, and policy and curriculum support that is not yet adaptive (Abou Karroum & Elshaiekh, 2023; Novianti, 2025; Nuryadin & Marlina, 2023; Vesna et al., 2025). This situation demands strengthening teacher professionalism through targeted training, not generic training that focuses on the technical aspects of device use.

Based on these conditions, this study focuses on the training needs of early childhood education (PAUD) teachers as a key factor in encouraging the effective use of AI-based applications. This study examines the influence of four key variables: teacher digital competence, openness to technology, infrastructure access, and institutional support on PAUD teacher training needs. The results are expected to provide an empirical basis for formulating policies and professional development programs for PAUD teachers relevant to the challenges of the Society 5.0 era.

Method

This study uses a quantitative explanatory approach to examine the influence of independent variables on the dependent variable through inferential statistical analysis. The study population included all non-formal early childhood education (PAUD) teachers in Arcamanik District, Bandung City. The research sample was determined using purposive sampling, with the criteria being PAUD teachers who are active in teaching and directly involved in the learning process. The sample size was set at 150 respondents, considering the adequacy of the sample size for multiple linear regression analysis, as stated by (Hamdan, 2018).

Data were collected using a standardised questionnaire measuring five constructs: teachers' digital competence, openness to technology, access to infrastructure, institutional support, and early childhood education teacher training needs. The research instrument was validated using Pearson Product-Moment correlation, and its reliability was assessed using Cronbach's alpha, with a value of ≥ 0.70. Data analysis was conducted using descriptive statistics, Pearson correlation tests, and multiple linear regression to examine simultaneous and partial effects between variables. Prior to regression analysis, the data were tested for normality, multicollinearity, and heteroscedasticity. All statistical analyses were conducted using SPSS software, following commonly used analysis procedures in quantitative educational research (Ghozali et al., 2016; Iskandar et al., 2018; Mansyur et al., 2017; Sugiono, 2016).

Results and Discussion

Result

Based on the results of a descriptive statistical analysis of 150 PAUD teacher respondents, a general overview was obtained of the conditions for each research variable, including teachers' digital competence, open attitudes towards technology, access to infrastructure, institutional support, and PAUD teacher training needs.

Table 1. Results of statistical description analysis

	N	Minimum	Maximum	Mean	Standard Deviation
Teacher Digital Competence	150	13	25	20.72	2,380
Open Attitude	150	15	25	21.06	2,945
Infrastructure Access	150	12	25	19.75	2,712
Institutional Support	150	13	25	20.25	2,766
Training Needs	150	15	25	22.93	2,408
Valid N (listwise)	150				

In Table 1, the results of the statistical description analysis show that the teacher's digital competence variable has an average value (mean) of 20.72 with a standard deviation of 2.380, a minimum value of 13, and a maximum of 25. These results indicate that, in general, the digital competence of PAUD teachers falls into the sufficient-to-high category,

although there are still variations in abilities between respondents. The relatively small standard deviation indicates that teachers' digital competence tends to be relatively uniform. The variable of open attitude towards technology has a mean of 21.06, a standard deviation of 2.945, a minimum of 15, and a maximum of 25. These findings indicate that most PAUD teachers have a fairly positive attitude towards the use of technology in learning. However, the larger standard deviation compared to other variables indicates differences in teachers' attitudes towards accepting and utilising digital technology.

Furthermore, the infrastructure access variable had a mean of 19.75, a standard deviation of 2.712, a minimum of 12, and a maximum of 25. These results indicate that access to technological infrastructure, such as ICT devices and internet networks, is sufficient. Score variations indicate that not all PAUD teachers have the same level of access to infrastructure, which could affect their opportunities to participate in digital-based training. The institutional support variable had a mean of 20.25, a standard deviation of 2.766, a minimum of 13, and a maximum of 25. These findings indicate that, in general, PAUD teachers have received sufficient institutional support from their workplaces, both in the form of policies, facilitation, and a work climate that supports professional development. However, there is still variation in support between PAUD institutions.

Meanwhile, the variable of early childhood education teacher training needs has the highest average value, namely 22.93, with a standard deviation of 2.408, a minimum value of 15, and a maximum of 25. These results indicate that early childhood education teachers have high levels of training needs, especially in meeting the demands of learning in the digital era. The high average value of training needs indicates teachers' awareness of the importance of continuous competency improvement. Overall, the descriptive statistics show that the training needs of early childhood education teachers are in the high category, while the variables of digital competence, openness to technology, infrastructure access, and institutional support are in the moderate-to-high category. These findings provide an initial indication that the training needs of early childhood education teachers are not only influenced by limited competencies but also by readiness, attitudes, and support from the work environment, so that training development needs to be designed comprehensively and based on the real needs of teachers. Based on the Pearson correlation analysis, all independent variables are positively and significantly related to the dependent variable, namely the training needs of early childhood education teachers. The significance values for all correlations are shown as Sig. <0.01, which means the relationship between variables is significant at the 99% confidence level.

Table 2. Correlations

		Digital Competence	Open Attitude	Infrastructure Access	Institutional Support	Training Needs
Teacher Digital Competence	Pearson Correlation	1	.602**	.438**	.509**	.674**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	150	150	150	150	150
Open Attitude	Pearson Correlation	.602**	1	.554**	.567**	.721**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	150	150	150	150	150
Infrastructure Access	Pearson Correlation	.438**	.554**	1	.638**	.605**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	150	150	150	150	150
Institutional Support	Pearson Correlation	.509**	.567**	.638**	1	.637**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	150	150	150	150	150
Training Needs	Pearson Correlation	.674**	.721**	.605**	.637**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	150	150	150	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows a strong, positive correlation (r = 0.674) between teachers' digital competency and PAUD teacher training needs. This finding indicates that the higher a teacher's digital competency, the greater their awareness of and need for further training to adapt to developments in educational technology.

Table 3. Summary of Pearson correlation matrix

Variables	X1	X2	X3	X4	Y
X1	1	0.602**	0.438**	0.509**	0.674**
X2	0.602**	1	0.554**	0.567**	0.721**

Variables	X1	X2	X3	X4	Y
X3	0.438**	0.554**	1	0.638**	0.605**
X4	0.509**	0.567**	0.638**	1	0.637**
Y	0.674**	0.721**	0.605**	0.637**	1

In Table 3, the variable openness to technology shows the strongest relationship with PAUD teachers' training needs, with a correlation coefficient of r = 0.721. These results indicate that PAUD teachers with a positive, open attitude toward technology tend to have higher training needs. This finding confirms that psychological attitude factors play a significant role in determining teacher readiness to develop professional competencies in the digital era. Furthermore, access to infrastructure is positively and significantly related to PAUD teachers' training needs, with a correlation coefficient of r = 0.605. These results indicate that the availability of technological devices, internet networks, and other supporting facilities is closely related to the increasing need for teachers to participate in digital-based training. Teachers with better access to infrastructure tend to be more motivated to develop their professional skills through training.

The institutional support variable also has a positive and significant relationship with the training needs of early childhood education (PAUD) teachers, with a correlation coefficient value of r = 0.637. This finding indicates that support from early childhood education institutions, whether in the form of policies, training facilitation, or a conducive work climate, contributes to the increasing need for teachers to participate in training and ongoing professional development. In addition to the relationship with the dependent variable, the correlation matrix results also indicate a positive relationship among the independent variables. This relationship remains within reasonable limits and does not indicate excessive multicollinearity, so the independent variables remain suitable for simultaneous use in multiple linear regression.

Overall, the Pearson correlation analysis indicates that higher levels of digital competence, openness to technology, infrastructure access, and institutional support are associated with a greater need for early childhood education teacher training in the digital era. These findings provide a strong empirical basis for continuing the analysis to the multiple linear regression stage to test the influence of each variable simultaneously and partially. The reliability test of the research instrument was conducted to assess the internal consistency of the statement items in measuring each research variable. Reliability testing was carried out using Cronbach's Alpha coefficient in SPSS. An instrument is considered reliable if its Cronbach's alpha is ≥ 0.70.

Table 4. Reliability test results (Cronbach's Alpha) per variable

Variables	Number of Items	Cronbach's Alpha
Teacher Digital Competence (X1)	5	0.752
Technology Attitude (X2)	5	0.806
Infrastructure Access (X3)	5	0.755
Institutional Support (X4)	5	0.775
Training Needs (Y)	5	0.813

Table 4 shows that the reliability test results indicate all research variables had Cronbach's Alpha values above the minimum threshold, thereby declaring the instrument reliable and suitable for data collection. The teacher's digital competence variable obtained a Cronbach's alpha of 0.8xx, indicating that the statement items in this variable have high internal consistency. This indicates that the teacher digital competence instrument consistently measures the same construct.

The openness to technology variable has a Cronbach's alpha of 0.8xx, indicating that all statement items within this variable are reliable and internally correlated. This finding indicates that the attitude instrument towards technology has been well-designed and consistently captures teachers' attitudes. Furthermore, the infrastructure access variable had a Cronbach's alpha of 0.7xx, indicating good reliability. This indicates that the statement items used to measure access to technology infrastructure have adequate internal consistency. The institutional support variable also showed a Cronbach's alpha of 0.8xx, indicating high reliability. The items in this variable consistently measure the form of support that teachers receive from early childhood education institutions.

Meanwhile, the variable for early childhood education teacher training needs obtained a Cronbach's alpha of 0.8xx, indicating that the training needs instrument has excellent internal consistency. This indicates that the statement items can reliably and consistently represent teacher training needs. The results of the reliability test indicate that all research

instruments exhibit good to excellent reliability. Thus, this research instrument is deemed feasible and reliable for further analyses, such as correlation and multiple linear regression.

Based on the results of the instrument reliability test, which showed that all research variables had Cronbach's Alpha values above the specified minimum limit, it can be concluded that the research instrument has met the internal consistency requirements and is suitable for further analysis. In addition, the descriptive statistics and Pearson correlation analysis indicate that all independent variables are positively and significantly related to the dependent variable, namely, the need for early childhood teacher training. Furthermore, before conducting the multiple linear regression analysis, the research data were tested for classical assumptions, including normality, multicollinearity, and heteroscedasticity. The results of the classical assumption tests (in the appendix) indicate that the data are normally distributed, there are no signs of multicollinearity among the independent variables, and no heteroscedasticity problems were found. Thus, this research data meets the requirements for multiple linear regression analysis.

A multiple linear regression analysis was conducted to determine the influence of teachers' digital competence, openness to technology, infrastructure access, and institutional support on the training needs of early childhood education (PAUD) teachers, both simultaneously and partially. This analysis aims to obtain a more comprehensive picture of the factors that significantly influence the training needs of early childhood education (PAUD) teachers in the digital era. By conducting multiple linear regression analysis, this study not only describes the relationships between variables but also explains the relative contribution of each independent variable to the dependent variable. Therefore, the results of the multiple linear regression analysis serve as the primary basis for the discussion and drawing conclusions of this study.

A multiple linear regression analysis was conducted to examine the influence of teachers' digital competence, openness to technology, access to infrastructure, and institutional support on the training needs of early childhood education (PAUD) teachers in the digitalisation era. This analysis included a coefficient of determination test, a simultaneous test (F-test), and a partial test (t-test). The regression analysis yielded an R value of 0.817, indicating a strong relationship between the independent and dependent variables. The Adjusted R^2 value of 0.659 indicates that 65.9% of the variation in PAUD teacher training needs is explained by teachers' digital competence, openness to technology, infrastructure access, and institutional support. Meanwhile, 34.1% of the remaining variation is attributable to other factors not examined in this study, such as teaching experience, teacher age, local government policies, and school organisational culture. These findings indicate that the regression model used has good predictive ability.

The results of the simultaneous test showed a calculated F-value of 72.908, with a significance level of 0.000 ($p < 0.05$). This means that teachers' digital competence, openness to technology, access to infrastructure, and institutional support collectively have a significant influence on the need for early childhood education (PAUD) teacher training. Thus, the regression model developed in this study is deemed suitable for explaining the phenomenon of PAUD teacher training needs in the digital era. This finding confirms that PAUD teacher training needs result from an interaction between individual and institutional factors.

In addition, the results of the partial test or t-test of Teachers' digital competency on the Needs of Early Childhood Education Teacher Training show that teachers' digital competency has a positive and significant effect on the needs of Early Childhood Education teacher training, with a regression coefficient value of B = 0.305, t value = 4.861, and Sig. = 0.000 < 0.05. This indicates that the higher the digital competency of Early Childhood Education teachers, the greater their need for further training. This finding indicates that teachers with stronger digital skills tend to have greater awareness of the importance of continuous professional development in the digital era.

The Influence of Open Attitudes to Technology on the Need for Early Childhood Education Teacher Training
The variable of open attitude towards technology shows a positive and significant influence on the training needs of PAUD teachers, with a regression coefficient value of B = 0.337, t value = 6.048, and Sig. = 0.000 < 0.05. In addition, the Standardised Beta value of 0.344 indicates that this variable is the most influential factor in determining the training needs of PAUD teachers. This finding indicates that teachers' psychological attitudes towards technology are the key factors in determining their readiness and training needs in the digital era.

The Impact of Infrastructure Access on Early Childhood Education Teacher Training Needs
The partial test results show that infrastructure access has a positive and significant effect on PAUD teachers' training needs, with a regression coefficient of B = 0.146, t = 2.516, and Sig. = 0.013 < 0.05. These findings indicate that the

availability of technological devices, internet networks, and other supporting facilities contributes to the increasing need for PAUD teachers to participate in digital-based training.

The Influence of Institutional Support on Early Childhood Education Teacher Training Needs
Institutional support also has a positive and significant effect on PAUD teachers' training needs, with a regression coefficient of B = 0.161, t = 2.737, and Sig. = 0.007 < 0.05. This indicates that support from PAUD institutions, whether in the form of policies, training facilitation, or a conducive work climate, plays an important role in encouraging teachers to develop their professional competencies through training.

Multiple Linear Regression Equation
Based on the analysis results, the following regression equation was obtained:

$Y = 4.553 + 0.305X_1 + 0.281X_2 + 0.146X_3 + 0.161X_4$

The Equation shows that all independent variables contribute positively to PAUD teachers' training needs.

Discussion

The findings of this study confirm that the need for early childhood education (PAUD) teachers to utilise AI-based applications is a multidimensional phenomenon influenced by individual factors and the institutional environment. The dominant influence of openness to technology indicates that teachers' psychological readiness plays a significant role in driving the need for professional development. Teachers with positive attitudes toward technology tend to be more aware of the importance of advanced training to address AI-based pedagogical changes (Selwyn, 2024; Svoboda, 2024). Simultaneously, the four independent variables explain most of the variation in PAUD teachers' training needs. This is in line with the view (Caena & Redecker, 2019) which emphasises that "teachers' digital competence is not a static attribute but a dynamic construct that requires continuous professional development".

This statement emphasises that the need for training does not stop when teachers have acquired basic competencies, but rather increases with awareness of the ever-changing developments in educational technology. The significant influence of teachers' digital competencies indicates that increasing technological capabilities actually broadens teachers' awareness of new limitations and challenges, thus creating a need for ongoing training. Furthermore, access to infrastructure and institutional support play supporting roles, enabling teachers to implement training outcomes effectively in their learning practices. These findings align with the view that integrating educational technology requires a supportive ecosystem, not just individual skill enhancement (Abou Karroum & Elshaiekh, 2023; Vesna et al., 2025).

The research results show that teachers' digital competence has a positive and significant impact on the training needs of early childhood education teachers. This finding indicates that teachers with greater digital competence tend to have greater awareness of their own limitations and the need for continuous learning. This aligns with the opinion of (Sun et al., 2019) which states that teachers' digital competencies encourage the need for further training as part of ongoing professional development.

Furthermore, openness to technology proved to be the most influential variable in shaping the training needs of PAUD teachers. This finding confirms that teachers' psychological readiness plays a key role in the digital transformation, within the Technology Acceptance Model, which states that "an individual's attitude toward using a system is a major determinant of whether the system will actually be used." In the context of this study, a positive attitude toward technology encourages PAUD teachers to be more active in seeking and participating in digital training as an effort to improve the quality of learning (Jahangiri et al., 2021).

The influence of infrastructure access on the training needs of early childhood education (PAUD) teachers also underscores the availability of technological resources as a crucial prerequisite for developing digital competencies. These findings suggest that PAUD teachers with better access to infrastructure tend to have higher training needs because they have greater opportunities to utilise technology in their learning. Furthermore, institutional support also significantly influences PAUD teacher training needs. Support in the form of school policies, training facilitation, and a conducive work climate encourages teachers to continuously develop their professional competencies. Thus,

institutional support is a crucial factor in strengthening PAUD teachers' motivation to participate in training and develop themselves in the digital era.

Overall, the results of this study indicate that the training needs of early childhood education (PAUD) teachers in the digital era cannot be understood solely in terms of technical skills. Openness to technology, digital competence, access to infrastructure, and institutional support interact to shape teacher training needs. Therefore, the design of PAUD teacher training programs should be comprehensive, taking into account technical, psychological, and institutional aspects in an integrated manner. These findings reinforce the view that PAUD teacher training in the digital era must be designed as a continuous professional development process that responds to the real needs of teachers and the context of educational institutions. With this approach, training is expected to improve PAUD teachers' readiness to integrate technology effectively and meaningfully into early childhood learning.

Conclusions and Suggestions

Conclusions

This study provides empirical evidence that the training needs of early childhood education (PAUD) teachers in utilising artificial intelligence (AI)-based applications are multidimensional. These needs are not solely shaped by limited technical skills but also by the interaction between individual teacher readiness and the institutional conditions in which they work. Digital competence, openness to technology, access to infrastructure, and institutional support collectively form a framework explaining why PAUD teachers perceive AI training as a pressing professional need.

Key findings indicate that teachers' openness to technology and digital competency play the most prominent role in shaping training needs. This indicates that training needs do not solely reflect competency deficits, but also reflect teachers' level of professional awareness of the increasing complexity of learning practices in the digital age. Teachers who are more cognitively and affectively prepared are better able to recognise their own limitations and assess the importance of continuous competency development.

From an institutional perspective, the significant influence of infrastructure access and organisational support suggests that training needs are also influenced by tangible opportunities to implement innovation. A work environment that provides technological resources and legitimises professional learning encourages teachers to view training as an integral part of pedagogical practice, rather than as an additional activity separate from the primary task of teaching.

Overall, this research reinforces the understanding that early childhood education teacher training needs in the context of AI should be understood as an indicator of adaptive readiness for educational transformation. Therefore, early childhood education teacher professional development needs to be positioned as a continuous, strategic process, aligned with technological changes, child development needs, and support from the overall education system.

Suggestions

For Education Policy Makers
Policymakers are advised to formulate early childhood education teacher training policies that are empirically based on needs and long-term. AI training programs should not be treated as ad hoc activities, but rather as part of national and regional strategies for the digital transformation of education. Policies should also integrate infrastructure strengthening, ongoing mentoring, and ethical guidelines for the use of AI that align with the characteristics of early childhood education.

For Early Childhood Education Institutions
Early childhood education institutions are expected to build an institutional ecosystem conducive to technology-based pedagogical innovation. This includes providing adequate technological resources, managerial support for teacher professional development, and creating spaces for reflection and collaboration among educators. With such support, AI training can be implemented consistently and have a tangible impact on learning practices.

For Early Childhood Education Teachers
Early childhood education teachers are advised to view the development of digital competencies and AI literacy as integral to teacher professionalism in the Society 5.0 era. An open attitude toward technology needs to be accompanied

by a reflective and critical approach in selecting and utilising AI applications to align with children's developmental needs. Active involvement in training and professional learning communities is expected to strengthen teachers' capacity to integrate AI pedagogically and responsibly.

For Further Researchers

Future research is recommended to develop a more comprehensive analytical model by incorporating other psychological and organisational variables, such as technology self-efficacy, school leadership, and innovation culture. Furthermore, using a longitudinal design or mixed-methods approach would enable the long-term examination of the impact of AI training on changes in instructional practices and the quality of early childhood learning experiences.

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