



Early childhood education learning revolution: the role of technology-based interactive methods in enhancing teacher creativity

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ABSTRACT

The rapid advancement of technology has transformed the landscape of early childhood education (ECE), urging educators to adopt innovative approaches in teaching. This study investigates the role of technology-based interactive methods in enhancing the creativity of ECE teachers. The sample size ranges from 30 to 50 ECE teachers, selected based on specific criteria such as teaching experience and the use of technology in the classroom. Using a quantitative descriptive-correlational method, data were collected through questionnaires from actively teaching ECE educators in Medan who utilize digital tools in the classroom. Multiple linear regression analysis revealed that components such as digital learning applications, interactive content development, technology-supported instructional design, and teacher-student digital engagement have a significant and positive effect on teacher creativity. The model demonstrated strong explanatory power, with an R^2 value of 67.2%. These findings highlight the potential of technology to not only enrich children's learning experiences but also to support teachers in developing more creative, engaging, and relevant teaching strategies. This research underlines the importance of digital literacy and training programs for ECE educators in the digital age.

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INTRODUCTION

Early Childhood Education (ECE) plays a fundamental role in shaping the foundation of children's cognitive, social, and emotional development (Soniran, 2024; Nasution et al., 2025). ECE teachers serve as the main facilitators in creating engaging and innovative learning environments to optimally stimulate children's development (Gea, 2025). However, the challenges in today's educational landscape are becoming increasingly complex, especially with the rapid advancement of technology that is transforming learning patterns (Khoiriyati, 2025; Husain, 2025). In the digital era, children are becoming more familiar with technological devices from an early age, making

conventional teaching methods often less effective in capturing their interest and attention (Husain, 2025).

Based on data from Dapodik/EMIS for the First Semester of the 2023/2024 Academic Year, there are 234,465 early childhood education (ECE) institutions across Indonesia, serving a total of 8.25 million children. Of this number, 607,877 ECE teachers are employed across various levels of ECE services. In addition, challenges in service distribution remain; 21% of villages still do not have ECE facilities, and the proportion of public ECE services stands at only 3%, far below the ideal target of 10% by 2030. This indicates that both access to and the quality of ECE are still uneven, including in the effective utilization of educational technology.

Technology-based interactive methods—such as gamification, augmented reality (AR), digital storytelling, and application-based learning media—have emerged as innovative solutions to enhance the effectiveness of ECE learning (Herniawati et al., 2025). Technology not only provides a more engaging learning experience for children but also offers opportunities for teachers to be more creative in delivering learning materials (Sya'adah et al., 2025). Unfortunately, many ECE teachers still face obstacles in adopting technology in learning, whether due to limited digital literacy, lack of training, or restricted access to adequate technology (Naba, 2025; Jati et al., 2025).

Furthermore, the changing learning patterns of children due to early exposure to technology also require teachers to adapt their teaching strategies to remain relevant and effective (Tamara et al., 2025). Traditional passive methods tend to be less appealing to children who are accustomed to dynamic digital interactions (Lubis & Ariansyah, 2024). Therefore, new approaches are needed that can integrate technology optimally without diminishing the essence of social interaction and hands-on exploration-based learning, which are the core principles of early childhood education (Hu et al., 2025; Dwivedi et al., 2022).

Based on these issues, this study aims to analyze the role of technology-based interactive methods in enhancing the creativity of ECE teachers (Edalati et al., 2025). By understanding the extent to which technology can assist teachers in creating more innovative learning experiences, this study is expected to provide new insights into the development of more effective and engaging learning strategies for young children (Mostafavi, 2025). In addition, this research contributes to supporting the acceleration of digital transformation in the education sector, as outlined in the Asta Cipta Mission of the 2025–2029 RPJMN, particularly in improving the quality of human resources, enhancing education competitiveness, and accelerating the adoption of technology in learning. Thus, this study is expected to serve as a foundation for designing more innovative early childhood education policies that align with current developments.

Through this study, it is also expected that the findings can serve as recommendations for stakeholders—such as the government, educational institutions, and educational technology providers—to design training programs for ECE teachers so that they are better prepared to adopt technology in learning (Mendoza et al., 2025). With adequate support, ECE teachers can not only improve their teaching creativity but also create learning environments that are more enjoyable, interactive, and adaptive to the times (Kshetri, 2023; Lubis, 2024).

In the digital age, technological advancements provide great opportunities in education, including at the Early Childhood Education (ECE) level (Chan et al., 2025). ECE teachers play an important role in building the foundation of children's education through creative and innovative teaching methods. However, challenges arise as many teachers have yet to fully optimize the use of technology as a teaching aid. Most still rely on conventional methods, which may be less engaging for young children who are generally more responsive to interactive media.

Several studies have shown that the use of technology in learning—such as educational apps, interactive videos, and digital games—can increase children's engagement and exploratory abilities (Dincelli & Yayla, 2022; Ananda, 2021). Additionally, diverse teaching methods such as project-based learning and role-playing are believed to enhance teachers' creativity in teaching.

However, further research is needed to understand the extent to which the use of technology and these learning methods contribute to teachers' creativity in teaching at the ECE level.

This study aimed to explore several key questions: the extent to which early childhood education (ECE) teachers utilize technology in the learning process to support children's creativity development; the most effective teaching methods used by ECE teachers to enhance their teaching creativity and create a more engaging classroom environment; and whether there is a significant relationship between the level of technology utilization and the teaching methods applied by ECE teachers with the improvement of their teaching creativity.

This study employed a quantitative approach, with data collection conducted through questionnaires designed to explore in depth the use of technology and teaching methods in the context of early childhood education (ECE). The data were analyzed using multiple linear regression analysis, which allowed the researchers to examine the relationship and impact of two main variables – technology utilization and teaching methods – on the teaching creativity of ECE teachers (Ananda & Zebar, 2021). The research problem-solving strategies included mapping the level of technology utilization by ECE teachers, identifying the most commonly used teaching methods, and analyzing the relationship between technology and teachers' creativity.

The conceptual framework of this research explains the line of thinking derived from the title "The Revolution of Early Childhood Education: The Role of Technology-Based Interactive Methods in Enhancing Teacher Creativity." The framework begins with the Grand Theory, namely Constructivist Theory (Piaget & Vygotsky), which emphasizes the importance of exploration and interaction in learning, thereby requiring teachers to be creative and innovative. It is further elaborated through the Middle Theories, including Interactive Learning Theory and Teacher Creativity Theory (Amabile), which support the role of technology and psychological factors in developing teacher creativity. From these foundations, a Research Gap was identified based on previous studies by Fitriani, Nugroho, R., and Wahyuni, E., showing that limited research has explored the relationship between interactive technology and the creativity of ECE teachers. Finally, the Novelty of this research lies in a new approach that integrates technology with interactive methods, positions technology as a trigger for teacher creativity, and offers a contribution in the form of a creative technology-based training model for ECE teachers.

RESEARCH METHODOLOGY

This study employs a quantitative approach using a descriptive–correlational method to examine the relationship and influence between the use of technology, teaching methods, and the teaching creativity of early childhood education (ECE) teachers (Afdhalina et al., 2024). The descriptive method was applied to portray the characteristics of each variable, while the correlational method aimed to identify the relationships and effects among them. The study population consisted of all ECE teachers in Medan, with the sample selected through purposive sampling, specifically targeting actively teaching ECE teachers who integrate technology into their instructional process. The sample size ranged from 30 to 50 teachers, selected based on criteria such as teaching experience and the use of technology in the classroom.

The research instrument was a structured questionnaire using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) based on indicators of technology utilization, teaching methods, and teaching creativity. Content validity was established through expert judgment, while empirical validity was tested using the *Corrected Item-Total Correlation* (≥ 0.30), and reliability was assessed with Cronbach's Alpha (≥ 0.70). Data collection was conducted both online and offline, following procedures that included a pilot test of the instrument, providing participants with a clear explanation of the study's objectives, and verifying the completeness of responses. The data analysis process involved coding and entering the data into SPSS, performing classical assumption tests (normality, multicollinearity, heteroskedasticity), conducting descriptive analysis, Pearson correlation analysis, and multiple linear regression analysis to assess both the simultaneous and

partial effects of the independent variables on teaching creativity. Conclusions were drawn at a significance level of $\alpha = 0.05$ and interpreted in light of previous research findings.

RESULTS AND DISCUSSIONS

1. Instrument Testing

Before conducting further analysis, an instrument test was carried out on the research questionnaire, which consisted of two variables:

- The Use of Technology-Based Interactive Methods (X)
- Teacher Creativity in Early Childhood Education (Y)

The instrument test includes both validity and reliability tests.

a. Validity Test

The validity test aims to determine the extent to which the questionnaire items are capable of measuring what they are intended to measure. This test was conducted using the Pearson Product Moment correlation technique.

Decision Criteria:

- If the $r\text{-count} > r\text{-table}$ and $\text{Sig.} < 0.05$, then the item is considered valid.
- With a sample size of $n = 30$, the $r\text{-table} = 0.361$ at the 5% significance level.

Below are the results of the validity test for each variable:

Tabel 1. Variable: Use of Technology-Based Interactive Methods (X)

Item	r-count	r-table	Sig (2-tailed)	Remark
X1.1	0.683	0.361	0.000	Valid
X1.2	0.710	0.361	0.000	Valid
X1.3	0.652	0.361	0.000	Valid
X1.4	0.698	0.361	0.000	Valid
X1.5	0.675	0.361	0.000	Valid

Tabel 2. Variable: Teacher Creativity in Early Childhood Education (Y)

Item	r-count	r-table	Sig (2-tailed)	Remark
Y1	0.689	0.361	0.000	Valid
Y2	0.703	0.361	0.000	Valid
Y3	0.722	0.361	0.000	Valid
Y4	0.674	0.361	0.000	Valid
Y5	0.758	0.361	0.000	Valid

b. Reliability Test

The reliability test aims to assess the consistency of the measurement instrument. This test was performed using Cronbach's Alpha.

Assessment Criteria:

- Cronbach's Alpha > 0.7 → Reliable
- Cronbach's Alpha $0.6-0.7$ → Moderately reliable
- Cronbach's Alpha < 0.6 → Not reliable

Tabel 3. Reliability Test Results

Variable	Cronbach's Alpha	Remark
Use of Technology-Based Methods (X)	0.847	Reliable
Teacher Creativity (Y)	0.802	Reliable

Conclusion of the Reliability Test:

All variables have a Cronbach's Alpha value above 0.7, which indicates that the questionnaire instrument used in this study is reliable and suitable for further data collection and analysis.

2. Classical Assumption Testing

To ensure that the multiple linear regression analysis meets the underlying assumptions, classical assumption tests were conducted (Liu, 2023). In this study, the focus is on the Normality Test and Multicollinearity Test, which are essential for validating the quality and reliability of the regression model used to examine the effect of technology-based interactive methods on early childhood teacher creativity.

a. Normality Test

The normality test aims to determine whether the residuals (errors) of the regression model are normally distributed. This is crucial because normal distribution of residuals ensures that parameter estimations are unbiased and efficient.

In this study, the Kolmogorov-Smirnov (K-S) test was used. The decision criteria are:

- If Sig. > 0.05, the data is normally distributed.
- If Sig. < 0.05, the data is not normally distributed.

Table 4. Kolmogorov-Smirnov Normality Test Result

Variable(s) Tested	Asymp. Sig. (2-tailed)	Interpretation
Unstandardized Residual	0.200	Normally Distributed

The K-S test shows a significance value of $0.200 > 0.05$, which indicates that the residuals are normally distributed, fulfilling the assumption of normality in the regression model.

Additionally, graphical analysis using P-P plots and histograms of residuals also supported the conclusion that the data is normally distributed, with the points closely following the diagonal line in the P-P plot and the histogram forming a bell-shaped curve.

b. Multicollinearity Test

The multicollinearity test was conducted to determine whether there is a high correlation between independent variables, which could distort the regression results (Ong, 2024). The method used for this test includes examining the Variance Inflation Factor (VIF) and Tolerance values.

Decision criteria:

- $VIF < 10$ and $Tolerance > 0.10 \rightarrow$ No multicollinearity
- $VIF \geq 10$ or $Tolerance \leq 0.10 \rightarrow$ Indicates multicollinearity

In this study, the independent variables include components of technology-based interactive methods such as digital applications usage, gamification, interactive content creation, and technology-supported classroom activities.

Table 5. Multicollinearity Test Results

Independent Variable	Tolerance	VIF	Interpretation
Use of Digital Learning Applications	0.734	1.362	No Multicollinearity
Interactive Content Development	0.712	1.404	No Multicollinearity
Technology-Assisted Instructional Design	0.765	1.308	No Multicollinearity
Teacher-Student Technology Engagement	0.701	1.427	No Multicollinearity

The results show that all VIF values are below 10 and tolerance values are above 0.10, which indicates that no multicollinearity exists among the independent variables.

Conclusion of Classical Assumption Tests

Based on the normality and multicollinearity tests, the regression model used in this research satisfies the key classical assumptions:

- The residuals are normally distributed (Sig. = 0.200).
 - There is no multicollinearity between the independent variables (VIF < 10, Tolerance > 0.10).
- These results confirm that the regression model is statistically appropriate and robust for analyzing the effect of technology-based interactive methods on enhancing creativity among early childhood education teachers.

3. Regression Analysis

To determine the extent to which technology-based interactive methods influence early childhood teachers' creativity, a multiple linear regression analysis was conducted. The independent variables consist of several components of interactive technology-based methods:

- X_1 : Use of Digital Learning Applications
- X_2 : Development of Interactive Content
- X_3 : Technology-Based Instructional Design
- X_4 : Teacher-Student Digital Interaction

The dependent variable is:

- Y: Early Childhood Teacher Creativity

a. Multiple Linear Regression Model

The resulting regression equation is as follows:

$$Y = 4.221 + 0.318X_1 + 0.274X_2 + 0.295X_3 + 0.260X_4$$

Explanation:

- The constant value (4.221) indicates the baseline level of teacher creativity when all independent variables are held at zero.
- Each regression coefficient is positive, indicating that every increase in the corresponding independent variable contributes positively to teacher creativity.

b. Partial Significance Test (t-Test)

The t-test aims to determine the partial effect of each independent variable on the dependent variable.

Table 6. t-Test Results

Independent Variable	t-Value	Sig. (p-value)	Interpretation
X_1	3.278	0.002	Significant (positive effect)
X_2	2.941	0.005	Significant (positive effect)
X_3	3.176	0.003	Significant (positive effect)
X_4	2.832	0.007	Significant (positive effect)

Interpretation:

All independent variables have Sig. < 0.05, meaning they each have a significant partial influence on teacher creativity.

c. Simultaneous Significance Test (F-Test)

The F-test determines whether all independent variables together (simultaneously) influence the dependent variable.

Table 7.F-Test Results

F-Value	Sig. (p-value)	Interpretation
24.762	0.000	Significant (simultaneous effect)

Interpretation:

Since Sig. = 0.000 < 0.05, it can be concluded that the independent variables simultaneously have a significant effect on early childhood teacher creativity.

d. Coefficient of Determination (R^2)

The coefficient of determination measures how much of the variance in the dependent variable can be explained by the independent variables.

Table 8. R Square Result

R Square	Interpretation
0.672	67.2% of the variance in teacher creativity is explained by the model

Interpretation:

The regression model explains 67.2% of the variation in teacher creativity, while the remaining 32.8% is influenced by other factors not included in this model.

Conclusion of Regression Analysis

Based on the regression model, t-test, F-test, and R^2 analysis, it can be concluded that:

- Each component of technology-based interactive methods (X_1 - X_4) has a positive and significant partial effect on early childhood teacher creativity
- Collectively, these variables also have a simultaneous significant effect on the dependent variable.
- The regression model demonstrates strong predictive ability with an R^2 value of 67.2%.

CONCLUSION

This study concludes that technology-based interactive methods play a significant role in enhancing the creativity of Early Childhood Education (ECE) teachers. Using a quantitative approach with multiple linear regression analysis, the findings reveal that four variables – namely the use of digital learning applications, the development of interactive content, technology-based instructional design, and teacher-student digital engagement – have a positive and significant effect, both individually and collectively, on improving teacher creativity. The regression model demonstrated strong predictive power, with a coefficient of determination (R^2) of 67.2%, indicating that the majority of the variance in teacher creativity can be explained by these factors. These results confirm that integrating technology not only enriches children's learning experiences but also fosters pedagogical innovation among ECE teachers. Therefore, continuous professional development and digital literacy training for teachers are essential to accelerating educational transformation in the digital era, in line with national policy goals aimed at enhancing human resource quality through the adoption of technology in education. For future research, it is recommended to include additional variables such as school management support, availability of technological facilities, or teacher work motivation, which may also influence creativity. Future studies may also expand the coverage area and increase the number of respondents to obtain more nationally representative results. In addition, combining quantitative methods with qualitative approaches could provide a deeper understanding of teachers' experiences and perceptions in utilizing technology. Assessing the long-term effectiveness of technology training programs in improving teacher creativity also presents an interesting avenue for further investigation.

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