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Teacher Creativity in AI-Based Media: Predicting Elementary Students' Interest and Achievement in Social Studies

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ABSTRACT

Despite the growing adoption of AI-based learning media in elementary education, teachers' pedagogical creativity in optimizing these tools remains underexplored, particularly in Social Studies (IPS) within the Society 5.0 framework. Previous studies have focused on technology adoption and learning effectiveness at secondary and higher education levels, with limited attention to how teacher creativity bridges AI integration and student outcomes at the elementary level. This study addresses this gap by analyzing the effect of teachers' creativity in using AI-based learning media on elementary students' learning interest and learning outcomes. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, a quantitative ex-post facto design was employed at MI Muhammadiyah Baruamba, involving 68 students in grades IV to VI. Data were collected through a teacher creativity questionnaire, a learning interest questionnaire, and a learning achievement test. Simple and multiple linear regression analyses revealed that teacher creativity significantly affects learning interest ($\beta = 0.634$; $R^2 = 0.402$; $p < 0.05$) and learning outcomes ($\beta = 0.608$; $R^2 = 0.370$; $p < 0.05$). Simultaneously, teacher creativity accounts for 72.9% of the explained variance across both outcomes ($R^2 = 0.729$; $p < 0.05$). These findings indicate that teachers' pedagogical creativity in integrating AI-based media enhances students' emotional engagement and academic achievement, confirming TPACK as a useful theoretical lens for understanding technology-enhanced elementary learning. The study suggests that professional development programs should prioritize pedagogical creativity alongside technical AI competencies.

INTRODUCTION

The integration of artificial intelligence (AI) technology into educational systems particularly in elementary Social Studies (IPS) has become an imperative in the Society 5.0 era; however, its implementation in elementary schools still faces a significant gap between technology utilization and teachers' pedagogical creativity. Although discourse

on digital transformation in education has expanded widely, most studies remain conceptual and macro in nature and have not specifically examined deeper pedagogical dimensions, particularly the role of teacher creativity in implementing AI-based learning media at the elementary school level (Basuni & Ningsih, 2025). Rachmadtullah et al. (2024) emphasized that most studies on digital transformation in elementary education still focus on technology use and general learning media development, with limited attention to teachers' pedagogical creativity in integrating AI-based technology into the learning process. Al-Zahrani and Alasmari (2024) also indicated that most studies on AI integration in education still focus on perceptions of technology use and learning effectiveness in higher education, with limited attention to teachers' pedagogical creativity in the use of AI-based learning media at the elementary school level.Digital transformation in education requires not only infrastructural readiness but also the adaptation of teachers' roles as facilitators of creative and innovative learning processes amid ongoing change (Ydyrysbayev et al., 2022). In the context of Society 5.0, technologies such as AI are not only used in the industrial sector but have also become central to the transformation of educational systems, aligning with demands for integration of technological and human values (Yaraş & Öztürk, 2022).

The digital divide has become a crucial issue in the process of educational digitalization, referring not only to disparities in access to technological infrastructure but also encompassing aspects of digital literacy, teacher competency, policy support, and school digital culture (Holmes et al., 2022). Schools with adequate resources can adopt digital and AI platforms in daily learning activities, thereby promoting increased student participation and learning independence (Devi & Winangun, 2024). Conversely, schools with limited facilities tend to rely on less adaptive conventional methods, potentially widening the gap in learning achievement and students' mastery of digital skills (Deursen & Dijk, 2019). Moreover, previous studies have tended to focus on secondary and higher education levels, positioning technology as the primary factor without elaborating in depth on the role of teacher creativity in determining the success of technology implementation in learning (Hwang et al., 2020).

The characteristics of Social Studies (IPS) subjects in elementary schools (SD/MI) necessitate a contextual, reflective, and socially grounded approach to learning

(Maharyati & Ningsih, 2025). Their use of AI-based learning media in this context necessitates teacher creativity in designing learning experiences that connect subject matter to real life, encourage discussion, and develop analytical skills appropriate to students' cognitive developmental stages (Boulhrir & Hamash, 2025). Learning interest is an important variable, as students' emotional engagement and intrinsic motivation significantly influence the depth of their comprehension and learning outcomes (Crompton & Burke, 2023). Students with high learning interest tend to be more active, enthusiastic, and focused in the learning process, which positively impacts learning outcomes. Conversely, low teacher competency in using technology innovatively contributes to diminished student engagement (Zikrifah & Suhaimy, 2023).

Despite the growing body of literature on AI in education, a critical research gap remains, as most studies treat technology as the primary variable and overlook the role of teachers' pedagogical creativity as a direct contributing factor in technology-enhanced learning at the elementary level. No empirical study has simultaneously examined the direct effects of teacher creativity on both affective and cognitive outcomes. This study is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, in which teacher creativity is operationalized through Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) in designing innovative AI-based learning activities (Koehler & Mishra, 2013), which posits that effective technology integration requires the dynamic intersection of technological, pedagogical, and content knowledge. Within this framework, teacher creativity is conceptualized as the capacity to synthesize relevant knowledge domains to design adaptive, engaging, and contextually relevant learning experiences.

Although some references cited in this study are from 2025–2026, they were accessed as online-first or early-view publications during the manuscript preparation phase and reflect the most current scholarship available at the time of writing.

This study, therefore, aims to fill the identified gap by empirically analyzing the simultaneous effect of teachers' creativity in using AI-based learning media on students' learning interest and learning outcomes at MI Muhammadiyah Baruamba. The findings are expected to contribute theoretically to the TPACK-informed understanding of teacher

creativity in Society 5.0 and practically to inform professional development programs focused on pedagogical innovation in AI-integrated elementary education.

METHOD

This study employed a quantitative research approach with an ex-post facto design to analyze the association between teachers' creativity in utilizing AI-based learning media and students' learning interest and learning outcomes in the era of Society 5.0. The research was conducted at MI Muhammadiyah Baruamba during the second semester of the 2025/2026 academic year, with participants drawn from students across grades IV to VI. The sampling technique used was purposive sampling with specific inclusion criteria, with a total sample of 68 students. The criteria for sample selection were as follows: (1) students in grades IV–VI who actively participated in AI-based learning; (2) students taught by teachers who had consistently used AI-based learning media for at least the past three months, as verified through a triangulated confirmation process comprising review of teachers' lesson plans (RPP), examination of school learning activity records (learning journal), and written confirmation from the school principal; (3) students who were present during data collection; and (4) students for whom written consent from both the classroom teacher and school principal had been obtained prior to participation.

The research instruments consisted of three types: (1) a teacher creativity questionnaire comprising 25 Likert-scale items (1–5), developed based on TPACK indicators adapted from Koehler and Mishra and operationalized through three intersecting TPACK domains: Technological-Pedagogical Knowledge (TPK), reflecting creativity in integrating technology with pedagogical strategies; Technological-Content Knowledge (TCK), reflecting creativity in connecting technology with subject matter; and Pedagogical-Content Knowledge (PCK), reflecting creativity in designing content-appropriate teaching approaches; (2) a students' learning interest questionnaire consisting of 20 Likert-scale items (1–5), developed based on Hidi and Renninger's four-phase model of interest development, covering triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest; and (3) a learning outcomes test in the form of 30 multiple-choice questions aligned with the Social Studies curriculum for grades IV–VI, with item difficulty indices ranging from

0.32 to 0.78 and discrimination indices ranging from 0.31 to 0.65, indicating acceptable item quality across the test. Before use, all instruments were tested for validity and reliability. Validity testing was conducted using the Pearson Product-Moment correlation, with items considered valid if the calculated r-value exceeded the r-table value (r-table = 0.239; n = 68; $\alpha = 0.05$). Reliability testing was conducted using Cronbach's Alpha, with instruments considered reliable if $\alpha > 0.60$. The results of the validity and reliability tests are presented in Table 1.

Table 1
Results of Instrument Validity and Reliability Testing

Instrument	No. of Items	Valid Items	Invalid Items	Cronbach's Alpha	Description
Teacher Creativity Questionnaire	25	23	2	0.847	Reliable
Learning Interest Questionnaire	20	19	1	0.823	Reliable
Learning Outcomes Test	30	28	2	0.791	Reliable

Note. Items with r-calculated < r-table (0.239) were excluded from the final analysis

Invalid items were removed from the final analysis, and Cronbach's Alpha was recalculated after item deletion to ensure internal consistency reflects only the retained items.

Data were collected through three techniques: (1) distribution of questionnaires to teachers and students to measure teacher creativity and students' learning interest; (2) administration of a learning outcomes test to assess students' cognitive achievement; and (3) direct observation of the learning process, which was used solely for contextual description of AI-based media implementation in the classroom and was not incorporated into the statistical analysis.

Before hypothesis testing, the data were analyzed using a series of classical assumption tests, including: (1) a normality test using the Kolmogorov-Smirnov method to determine whether the data were normally distributed; (2) a linearity test to examine whether the relationships between variables were linear; and (3) a heteroscedasticity test using the Glejser method to ensure the absence of variance inconsistency in the residuals, which showed no significant correlation between residuals and the independent variable, confirming homoscedasticity ($p > 0.05$ for all variables). All classical assumption tests were conducted using SPSS version 26. Data that met all classical assumptions were

further analyzed using simple linear regression to examine the partial association between teacher creativity and learning interest and learning outcomes, and multiple linear regression to examine the simultaneous association. Hypothesis testing was conducted using the t-test for partial effects and the F-test for simultaneous effects, with a significance level of $\alpha = 0.05$.

This study was conducted in accordance with established ethical principles for educational research. Before data collection, written informed consent was obtained from the school principal and classroom teachers. For student participants who were minors, parental/guardian consent was secured through formal consent forms distributed by the school. All participants were informed of the voluntary nature of their participation and their right to withdraw at any time without consequence. Student data were anonymized, stored securely, and used solely for academic research purposes. The study received ethical approval was obtained from the Research Ethics Committee of Universitas Islam Negeri Saifudin Zuhri Purwokerto, which specifically approved the conduct of the study in external partner schools, including MI Muhammadiyah Baruamba.

RESULT AND DISCUSSION

This research was conducted at MI Muhammadiyah Baruamba, involving teachers and students of grades IV–VI as research subjects. The study aims to analyze the extent to which teachers' creativity in integrating AI-based learning media influences students' academic interest and learning outcomes in the Society 5.0 era. In addition to the primary quantitative data, supporting data were collected through classroom observations, and unstructured interviews were conducted with three teachers (one from each grade level) for data triangulation purposes. The findings are presented systematically in accordance with the research questions, beginning with descriptive statistics for each variable, followed by hypothesis testing both individually and collectively, and concluding with a discussion that integrates empirical findings with relevant theories and prior research.

Results

Teacher Creativity in AI-Based Learning Media

Teachers' creativity in integrating AI-based learning media at MI Muhammadiyah Baruamba is evident in their ability to design and present learning materials beyond

conventional methods. Drawing on the TPACK framework, teachers demonstrated creativity at the intersection of technological, pedagogical, and content knowledge by actively employing various AI-based platforms, including Canva AI for designing visually engaging teaching materials alongside Quizizz for creating interactive and formative assessments. Students responded positively to this approach, as evidenced by their active involvement throughout the learning process. Teacher interview responses were analyzed using thematic summarization, identifying recurring themes such as visual engagement, instructional efficiency, and peer collaboration. The findings are presented as illustrative quotations for triangulation purposes. A Grade V teacher noted that AI-based media facilitates more attractive content delivery, as students are more engaged with visual and interactive content. A Grade VI teacher mentioned that using ChatGPT to generate questions and lesson summaries improved teaching efficiency. A Grade IV teacher acknowledged that skills in operating AI platforms developed gradually through peer collaboration sessions, generating new creative ideas for lesson design.

Teacher creativity is further reflected in their ability to adapt the type of media to the characteristics of the material and students' learning needs, making the learning process more adaptive and varied. This indicates that teacher creativity at the madrasah has transcended the mere use of technology as an auxiliary tool and has become part of a deliberate and planned pedagogical strategy. The following descriptive statistical analysis of the teacher creativity variable (X) provides a more structured measurement of this creativity.

Table 2
Frequency Distribution of Teacher Creativity in AI-Based Learning Media

No.	Category	Score Range	Frequency (f)	Percentage (%)
1	Very Creative	93 – 125	11	16.18%
2	Creative	78 – 92	32	47.06%
3	Fairly Creative	63 – 77	19	27.94%
4	Less Creative	48 – 62	6	8.82%
5	Not Creative	25 – 47	0	0.00%
	Total		68	100%

As shown in Table 2, the teacher creativity variable (X) was measured using a 23-item Likert scale questionnaire (1–5), comprising the valid items from an initial pool of 25 distributed to 68 respondents. The results yielded a mean score of 82.40, a median of 83.00, a mode of 84.00, and a standard deviation of 7.35, with a minimum score of 63 and a maximum of 98. The majority of respondents (47.06%) fell in the Creative category (score 78–92), followed by Fairly Creative at 27.94%. No respondents fell in the Not Creative category, indicating that teacher creativity at MI Muhammadiyah Baruamba is generally at a satisfactory level in integrating AI-based learning media.

Students' Learning Interest (Y_1)

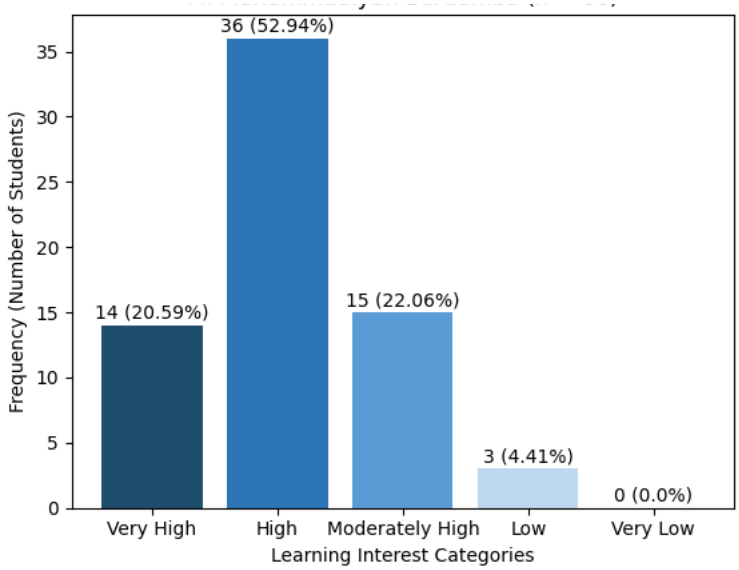
Students' learning interest in AI-based media-assisted learning was measured using a 19-item Likert-scale questionnaire (1–5), comprising the valid items from an initial pool of 20, distributed to 68 Grade IV–VI students. The indicators covered: (1) student attention to learning; (2) interest in the media used; (3) enjoyment in participating in lessons; and (4) active involvement in learning activities. The analysis yielded a mean of 76.32, a median of 77.00, a mode of 78.00, and a standard deviation of 8.14, with a minimum score of 55 and a maximum of 96. The frequency distribution is presented in Table 3.

Table 3
Frequency Distribution of Students' Learning Interests

No.	Category	Score Range	Frequency (f)	Percentage (%)
1	Very High	85 – 100	14	20.59%
2	High	70 – 84	36	52.94%
3	Moderate	55 – 69	15	22.06%
4	Low	40 – 54	3	4.41%
5	Very Low	20 – 39	0	0.00%
	Total		68	100%

Table 3 shows that most students fell into the High learning interest category, accounting for 52.94% (36 students), followed by the Moderate category at 22.06% (15 students), and the Very High category at 20.59% (14 students). Only 4.41% (3 students) were in the Low category, and no students fell in the Very Low category. The bar chart of this distribution is presented in Figure 1.

Figure 1
Bar Chart of Students' Learning Interest Distribution



As shown in Figure 1, the distribution of students' learning interest scores is positively skewed, with the peak at the High category (52.94%). This pattern indicates that AI-based media learning implemented by creative teachers positively influences students' intrinsic motivation to learn at MI Muhammadiyah Baruamba.

Students' Learning Outcomes (Y_2)

Students' learning outcomes (Y_2) were measured through a 28-item validated multiple-choice test, comprising the valid items from an initial pool of 30, administered to 68 Grade IV–VI students after the AI-based media learning process. The results yielded a mean of 79.26, a median of 80.00, a mode of 82.00, and a standard deviation of 9.47, with a minimum score of 58 and a maximum score of 97. The distribution based on Minimum Mastery Criteria (KKM = 75) is presented in Table 4.

Table 4
Frequency Distribution of Students' Learning Outcomes

No.	Category	Score Range	Frequency (f)	Percentage (%)
1	Very Good	86 – 100	18	26.47%
2	Good	76 – 85	27	39.71%
3	Sufficient	66 – 75	14	20.59%
4	Poor	< 66	9	13.24%
	Total		68	100%
	Mastery (KKM ≥ 75)		52	76.47%

Not Mastery (KKM < 75)	16	23.53%

KKM (Minimum Mastery Criteria) is the minimum standard of student achievement set by the school at a score of 75 based on curriculum standards and student characteristics

As shown in Table 4, 76.47% of students (52 out of 68) achieved the established KKM of 75. The mean learning outcome of 79.26 indicates that students' cognitive achievement is above the KKM and at a satisfactory level, suggesting that AI-based media-integrated learning was effective in improving students' mastery of the subject matter.

Classical Assumption Test

Before hypothesis testing, three classical assumption tests were conducted to ensure the validity of the regression model.

The Kolmogorov-Smirnov normality test yielded an Asymp. Sig. value of 0.142 (> 0.05) for the residuals of the teacher creativity–learning interest model, and 0.187 (> 0.05) for the teacher creativity–learning outcomes model, indicating that the residuals of both models are normally distributed.

The linearity test between teacher creativity (X) and learning interest (Y_1) produced a Deviation from Linearity significance value of 0.213 (> 0.05), and between teacher creativity (X) and learning outcomes (Y_2) a value of 0.178 (> 0.05), confirming significant linear relationships in both models.

The Glejser heteroscedasticity test showed significance values of 0.364 (> 0.05) and 0.291 (> 0.05), respectively, indicating that neither model exhibits heteroscedasticity. Since all classical assumption criteria were satisfied, the data were suitable for further regression analysis.

Effect of Teacher Creativity on Students' Learning Interest (H_1)

Their hypothesis (H_1) states that teacher creativity in using AI-based learning media has a significant effect on students' learning interest. Testing was conducted using simple linear regression analysis with teacher creativity (X) as the independent variable and learning interest (Y_1) as the dependent variable. The results are presented in Table 5.

Table 5
Simple Linear Regression: Teacher Creativity (X) on Students' Learning Interest (Y_1)

Model	B	Std. Error	Beta (β)	t	Sig.
(Constant)	18.427	5.312	–	3.469	0.001
Teacher Creativity (X)	0.703	0.064	0.634	10.984	0.000
$R = 0.634$ | $R^2 = 0.402$ | Adj. $R^2 = 0.393$					

Note. $R = 0.634$ | $R^2 = 0.402$ | Adj. $R^2 = 0.393$

As shown in Table 5, the regression equation is: $\hat{Y}_1 = 18.427 + 0.703X$. The positive regression coefficient of 0.703 indicates that every one-unit increase in teacher creativity predicts a 0.703-unit increase in students' learning interest. The t-test result yields t = 10.984 with significance = 0.000 < 0.05, meaning H_0 is rejected and H_1 is accepted. The coefficient of determination, $R^2 = 0.402$, indicates that teacher creativity explains 40.2% of the variance in students' learning interest. The remaining 59.8% is attributed to other factors such as the learning environment, parental support, and students' intrinsic motivation.

Effect of Teacher Creativity on Students' Learning Outcomes (H_2)

Their second hypothesis (H_2) states that teacher creativity in using AI-based learning media has a significant effect on students' learning outcomes. Simple linear regression analysis was applied with teacher creativity (X) as the independent variable and learning outcomes (Y_2) as the dependent variable. The results are presented in Table 6.

Table 6
Simple Linear Regression: Teacher Creativity (X) on Students' Learning Outcomes (Y_2)

Model	B	Std. Error	Beta (β)	t	Sig.
(Constant)	21.583	6.074	–	3.553	0.001
Teacher Creativity (X)	0.698	0.073	0.608	9.562	0.000
$R = 0.608$ | $R^2 = 0.370$ | Adj. $R^2 = 0.360$					

As shown in Table 6, the regression equation is: $\hat{Y}_2 = 21.583 + 0.698X$. The positive regression coefficient of 0.698 means that every one-unit increase in teacher creativity is associated with a 0.698-unit increase in learning outcomes. The t-test yields t = 9.562 with a p-value of 0.000 < 0.05, indicating H_0 is rejected, thereby accepting H_2. The value $R^2 = 0.370$ indicates that teacher creativity accounts for 37.0% of the variance

in students' learning outcomes, with the remaining 63.0% attributed to factors such as students' prior knowledge, learning motivation, and family environment.

Simultaneous Effect of Teacher Creativity on Learning Interest and Outcomes (H_3)

Their third hypothesis (H_3) states that teacher creativity simultaneously has a significant effect on both students' learning interest (Y_1) and learning outcomes (Y_2). Multiple linear regression analysis with the F-test was applied. The results are presented in Table 7.

Table 7
Multiple Regression F-Test: Teacher Creativity on Learning Interest and Outcomes

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3,847.214	2	1,923.607	87.432	0.000
Residual	1,428.653	65	21.979		
Total	5,275.867	67			
$R = 0.854$ | $R^2 = 0.729$ | Adj. $R^2 = 0.720$					

Note. $R = 0.854$ | $R^2 = 0.729$ | Adj. $R^2 = 0.720$

As shown in Table 7, the F-test yields F = 87.432 with a significance value of $0.000 < 0.05$, indicating that H_0 is rejected and H_3 is accepted. Teacher creativity in AI-based learning media has a significant positive effect on both students' learning interest and learning outcomes at MI Muhammadiyah Baruamba. The R^2 value of 0.729 indicates that teacher creativity explains 72.9% of the combined variance in learning interest and learning outcomes. The higher R^2 in the simultaneous model reflects overlapping shared variance between learning interest and learning outcomes that is jointly explained by teacher creativity, while the remaining 27.1% is influenced by factors outside the research model.

Discussion

Teaching Creativity and Students' Learning Interests

The finding that teacher creativity significantly affects students' learning interest ($\beta = 0.634$; $R^2 = 0.402$; $p < 0.05$) is theoretically grounded in the TPACK framework (Koehler & Mishra, 2013), which holds that teachers who creatively integrate technological, pedagogical, and content knowledge are better positioned to design learning environments that sustain student engagement. This finding is consistent with

Mou (2026), who confirmed a significant relationship between teachers' creativity and students' learning interest, whereby variation in media used by teachers demonstrably influences students' emotional engagement and learning motivation. It is further reinforced by Manik and Rahmi (2026), who found that teachers who creatively and responsibly integrate AI-based learning tools into their instruction can create more engaging and participatory classroom environments.

From the perspective of Hidi and Renninger's four-phase model of interest development, namely triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest, the use of AI-based tools such as Quizizz and Canva AI by creatively competent teachers serves as a trigger for situational interest. The findings of this study indicate that students have at least reached the maintained situational interest phase, as reflected in their more consistent engagement in the learning process (Perche et al., 2025). When teachers harness the interactive and visually stimulating affordances of AI platforms, students are psychologically motivated to engage more actively and enthusiastically in the learning process (Prasetyo & Rosyid, 2022). However, it is important to note that the situational interest observed in this study may have been temporary. As this study employed a cross-sectional design, it cannot determine whether such situational interest persists over time without deliberate scaffolding toward the development of individual interest. Therefore, future studies should examine the longitudinal dynamics of interest development in AI-enriched classrooms.

Teaching Creativity and Students' Learning Outcomes

The finding that teacher creativity significantly affects students' learning outcomes ($\beta = 0.608$; $R^2 = 0.370$; $p < 0.05$) is consistent with the Society 5.0 vision articulated by Fukuyama (2018), which calls for the creative integration of AI to address social challenges, including inadequate learning outcomes. The TPACK framework further explains this result: when teachers demonstrate high technological pedagogical content knowledge, they can present content that is more contextual, adaptive, and cognitively appropriate for students' developmental stages, thereby enhancing comprehension and academic achievement (Apoko & Yusnawati, 2025).

This finding is corroborated by Zawacki-Richter et al. (2019), who demonstrated that AI in adaptive learning significantly enhances elementary students' conceptual understanding through personalized approaches. The meta-analysis by Sung et al. (2016) further affirms a medium-to-large positive effect of AI-enabled adaptive learning on cognitive achievement. From Vygotsky's constructivist perspective, AI-based media creatively employed by teachers can serve as scaffolding within students' Zone of Proximal Development (ZPD) (Ferguson et al., 2022), enabling optimal competence development. Critically, however, $R^2 = 0.370$ indicates that teacher creativity alone accounts for only 37% of the variance in learning outcomes, a substantive but not dominant proportion. This underscores the importance of additional factors such as students' prior knowledge, socioeconomic background, parental support, and school infrastructure, which future research should integrate into more comprehensive explanatory models.

Simultaneous Effects on Affective and Cognitive Outcomes

The simultaneous contribution of teacher creativity to learning interest and outcomes ($R^2 = 0.729$; $F = 87.432$; $p < 0.05$) provides compelling evidence that teacher creativity meaningfully affects both affective and cognitive dimensions of learning. The combined explained variance of 72.9% underscores teacher creativity as a powerful predictor of overall learning quality in AI-enriched elementary settings. This finding extends the work of Mou (2026) and Ningsih (2021) by empirically testing a simultaneous, integrated model rather than isolated partial effects.

Theoretically, these findings are explained through two complementary lenses. First, from a constructivist perspective proposed by Vygotsky, teachers' creativity in integrating AI-based media encourages students to actively develop disciplinary knowledge via customized, contextually interactive learning experiences (Ansari & Qamari, 2025). Second, in the framework of TPACK and Society 5.0, digitally creative teachers play a catalytic role in transforming learning and addressing the challenges of 21st-century education. They not only deliver content more engagingly but also create a learning ecosystem that supports both intrinsic interest and optimal academic outcomes (Dogan, 2026; Fukuyama, 2018).

Limitations and Future Research Directions

Nevertheless, several limitations of this study warrant acknowledgment. First, the single-site design with a relatively small sample (n = 68) limits the generalizability of findings to broader elementary school contexts. Furthermore, the use of purposive sampling with specific inclusion criteria means that findings are only generalizable to similar contexts, specifically elementary schools with AI-ready teachers and adequate technological infrastructure and should not be extrapolated to broader or more diverse school settings. Second, the ex-post facto design precludes causal inference; the observed relationships are correlational and should be interpreted accordingly. Third, the study did not control for potential confounding variables such as students' prior academic achievement, teachers' years of experience, or school-level infrastructure support. Fourth, the teacher creativity instrument was completed by students as raters, which may introduce response bias. The most critical limitation of this study is its ex-post facto design, which prevents causal inference; therefore, the findings should be interpreted as associations rather than causal effects.

Future research is encouraged to employ experimental or quasi-experimental designs, expand sampling across multiple schools and regions, and explore the mediating and moderating roles of variables such as digital infrastructure quality and teacher professional development intensity. In particular, future studies should examine whether learning interest mediates the relationship between teacher creativity and learning outcomes using bootstrapping methods.

CONCLUSION

The central takeaway of this study is that how teachers creatively use AI-based learning media matters more than the AI technology itself; it is the teacher's pedagogical creativity that drives both student engagement and academic achievement in elementary school classrooms. Based on the results of data analysis and hypothesis testing, this study identifies three main findings.

First, teacher creativity in the use of AI-based learning media has a significant association with elementary students' learning interest (H_1 accepted; $\beta = 0.634$; $R^2 = 0.402$; $p < 0.05$), indicating that higher levels of teacher creativity in utilizing AI

technology as a learning medium correspond to higher levels of students' learning interest. Second, this creative integration also has a significant association with students' learning outcomes (H_2 accepted; $\beta = 0.608$; $R^2 = 0.370$; $p < 0.05$), suggesting that teachers' innovation in integrating AI-based media contributes substantially to improving students' academic achievement. Third, such creativity has a significant simultaneous association with both learning interest and learning outcomes (H_3 accepted; $R^2 = 0.729$; $F = 87.432$; $p < 0.05$), confirming that teacher creativity is a critical determining factor in the success of AI-based learning in elementary schools.

These findings carry important theoretical and practical implications. Theoretically, the results affirm TPACK as a useful conceptual lens for understanding teacher creativity in technology-enhanced elementary education within the Society 5.0 era. However, additional factors beyond TPACK, such as school infrastructure quality, students' prior academic achievement, and institutional support for innovation, warrant further theoretical integration to develop a more complete explanatory model.

Practically, these findings indicate that mastery of AI technology alone is insufficient without complementary pedagogical creativity in designing and delivering engaging, meaningful learning experiences. Teacher training and professional development programs should therefore prioritize not only technical AI competencies but also the continuous cultivation of pedagogical creativity, reflective practice, and learner-centered design. For instance, professional development workshops could include design-thinking sessions where teachers collaboratively modify existing AI-based lesson plans to better fit their unique classroom contexts, student needs, and available technological resources.

For future research, it is recommended that studies employ experimental designs, involve broader and more diverse samples across educational levels and regions, and examine moderating variables such as technological infrastructure availability, teachers' digital literacy levels, and institutional support for innovation. The most urgent next step is experimental replication across multiple schools with random assignment to isolate causal associations and establish a robust understanding of how teacher creativity shapes learning quality in AI-integrated elementary education.

Within the specific context of grades IV-VI Social Studies instruction at a single Islamic elementary school, this study found that teacher creativity in AI-based media integration is a significant and substantive predictor of both students' learning interest and academic achievement. Notably, even with creative AI teaching, nearly one-quarter of students (23.53%) remained below the established mastery level (KKM < 75), suggesting that teacher creativity alone cannot close all achievement gaps and that additional supportive factors, such as remedial programs, differentiated instruction, and parental involvement, remain necessary. What remains unknown is whether these associations persist over multiple school years, strengthen with increased teacher AI experience, or generalize to non-AI learning contexts and other elementary school subjects beyond Social Studies. School leaders should therefore provide structured peer-collaboration time for teachers to share and co-develop creative AI integration strategies, rather than expecting individual teachers to innovate in isolation without institutional support.

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