



## The Effect of Leadership, School Climate, and Scientific Literacy on Teacher Creativity with the Role of Artificial Intelligence in Senior and Vocational High Schools in Samarinda

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### ABSTRACT

This study examines the effects of principal leadership, school climate, and scientific literacy on teacher creativity, with artificial intelligence (AI) as an intervening variable. A quantitative survey was conducted involving 58 senior high school teachers in Samarinda. Data were collected through questionnaires and analyzed using SEM-PLS to evaluate the relationships among variables. The findings reveal that the model demonstrates good fit and predictive relevance. Principal leadership shows a positive but not statistically significant effect on teacher creativity, suggesting its role is supportive but not dominant. In contrast, school climate has a significant positive influence, indicating that a collaborative and supportive environment enhances creative teaching practices. Scientific literacy also significantly contributes to teacher creativity, emphasizing the importance of integrating scientific knowledge into instructional design. Furthermore, AI serves as a significant intervening variable, strengthening the relationship between the independent variables and teacher creativity. These results highlight the importance of integrating leadership, organizational climate, literacy, and technology in fostering teacher creativity. Practically, schools are encouraged to optimize leadership, build a conducive environment, and integrate AI to support innovative and effective learning.

## 1. Introduction

The rapid development of science and technology has had a significant impact on various aspects of life, including education. Current education is geared toward

equipping students to successfully face the challenges of the 21st century. The learning process emphasizes not only mastery of knowledge but also encompasses an understanding of the development of higher order thinking skills relevant to everyday life. According to Leong & Said (2023), creative teachers are able to develop science, technology, and the arts as a means to support students learning. In this context, teacher creativity is a key factor in designing learning that is innovative, adaptive, and relevant to students' needs (Meirink et al., 2020; Rahmadhani et al., 2023). However, various studies indicate that teachers' creativity still faces challenges in integrating innovative, technology-based and literacy-based learning approaches (Isma et al., 2023).

Theoretically, creativity is influenced by various factors, both individual and contextual. Previous research has highlighted the role of principal leadership as important determinants in enhancing teacher creativity (Bellibaş et al., 2024). Effective principals are believed to be able to create structural and psychological support for teachers to innovate. Furthermore, a conducive and collaborative school climate provides space for teachers to develop creative ideas, while scientific literacy plays a role in strengthening critical thinking and problem solving skills in learning (Alqorni, 2023; Dasic et al., 2024). However, empirical research findings indicate that a school's success in building an environment that fosters teacher creativity is largely determined by several important factors, including principal leadership, school climate, and scientific literacy, although other factors also influence this (Yuliani et al., 2025). Inspirational principal leadership and ongoing support have been shown to contribute to increased teacher creativity (Jabbar & Hussein, 2020). This indicates that the relationship between these variables and teacher creativity has not yet been fully and comprehensively explained.

The scope of technology utilization has been widely utilized in the field of education. The rapid advancement of science and technology, accompanied by the strong influence of globalization, requires teachers to have high creativity in managing classroom learning to produce optimal learning outcomes (Tumuheise et al., 2023). The application of Artificial Intelligence (AI) has many impacts in education, including its role in educational leadership and evaluation (Guo et al., 2025). By utilizing AI technology, learning can adapt to students strengths and weaknesses in analyzing education, making it easier to meet the needs of people with different backgrounds and abilities (Aspin & Abubakar, 2025). Several studies have shown that the use of AI can increase teacher creativity in designing learning (Alasgarova & Rzayev, 2025). However, studies that integrate AI as a bridging (intervening) variable in the relationship between school organizational factors and teacher creativity are still limited, especially in the context of quantitative research based on structural models. In addition, there is still a lack of empirical models that are able to simultaneously combine leadership factors, school climate, science literacy, and technology in a complete analytical framework to explain the increase in teacher creativity in the era of digital transformation.

Based on this study, there are still research gaps that require further attention. First, research findings on the influence of principal leadership, school climate, and scientific literacy on teacher creativity show inconsistent results. Second, studies

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integrating artificial intelligence as an intervening variable to explain the relationship between these variables are still limited. Third, there is limited research developing empirical models that simultaneously combine leadership, school environment, literacy, and technology factors to enhance teacher creativity. In the context of education, this description presents a different perspective. This research offers novelty by positioning artificial intelligence as an intervening variable linking leadership, school climate, and scientific literacy with teacher creativity, factors rarely studied comprehensively in quantitative educational research. Therefore, it is hoped that it will provide a better understanding, comprehensive regarding the mechanisms of relationships between variables and explaining the strategic role of technology in strengthening teacher creativity in learning. In line with this, this study aims to analyze the influence of principal leadership, school climate, and science literacy on teacher creativity through AI as an intervening variable. The results are expected to contribute significantly to formulating more effective school management strategies, particularly in optimizing factors that influence teacher creativity.

## **2. Methodology**

This study uses a quantitative approach with a survey method to empirically test the relationships and influences between variables based on numerical data (Sugiyono, 2022). This approach was chosen because it allows for objective hypothesis testing through systematic statistical analysis. The study was conducted at SMA Negeri 1, SMA Negeri 11, and SMK Negeri 14 in Samarinda City, which were selected due to the suitability of the school characteristics with the research objectives and the ease of access for researchers in data collection during the research period. The research population was the accessible population, namely all teachers who worked and taught at the three schools. The sampling technique used non-probability sampling with a purposive sampling approach, with the criteria for respondents being teachers who were actively teaching, willing to be respondents, and who completed the questionnaire completely (Sudjana, 2005). Based on the data collection process, 58 respondents were obtained who met the criteria and all were used as research samples. The sample size was considered adequate because this research used Structural Equation Modeling based Partial Least Squares (SEM-PLS), which does not require a large sample size and places more emphasis on the predictive ability of the model, and has fulfilled the 10 times rule, namely a minimum of ten times the number of the largest structural paths leading to one endogenous construct (Kadir, 2019).

### ***Instrument***

The research instrument used in this study was a structured questionnaire developed based on indicators for each variable, namely principal leadership, school climate, scientific literacy, AI, and teacher creativity. All items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree. To ensure the quality of the instrument, validity and reliability testing were conducted in multiple stages. First, content validity was established through expert judgment involving

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education experts to ensure that each item accurately represented the intended construct. Second, a pilot test was conducted on respondents outside the research sample to evaluate clarity, readability, and consistency of responses. Furthermore, construct validity and reliability were assessed using SEM-PLS through the evaluation of the measurement model (outer model). Convergent validity was evaluated based on outer loading values, where indicators are considered valid if they have loading factors greater than 0.70 (or 0.50 for exploratory research). Discriminant validity was assessed using the Average Variance Extracted (AVE) and cross-loading criteria, where AVE values must exceed 0.50. Reliability was evaluated using Composite Reliability and Cronbach's Alpha, with threshold values greater than 0.70. The results of these tests indicate that all constructs meet the required validity and reliability criteria, confirming that the instrument is appropriate for further analysis.

### ***Data Collection***

Data collection was conducted by distributing questionnaires directly to respondents at each school. The data collection procedure was carried out systematically, beginning with the preparation of the research instrument, followed by the validation and trial process of the instrument, and then distributing the questionnaires to respondents who met the sample criteria. After that, data collection and completeness checks were carried out to ensure that all questionnaires were completed correctly. The collected data were then coded and transformed into numerical form according to the measurement scale used, ready for further analysis using statistical software SEM-PLS.

### ***Data Analysis***

This study utilized descriptive statistical analysis and Structural Equation Modeling based on Partial Least Squares (SEM-PLS) using SmartPLS software. The first stage involved descriptive statistical analysis to describe respondent characteristics and the distribution of research data, including mean, standard deviation, minimum, and maximum values. This analysis provides an initial overview of the data. The second stage involved evaluating the measurement model (outer model) to assess construct validity and reliability. Convergent validity was examined through outer loading values, where each indicator must meet the minimum threshold. Discriminant validity was evaluated using the Average Variance Extracted (AVE) and cross loading values to ensure that each construct is distinct. Reliability was assessed using Composite Reliability and Cronbach's Alpha, ensuring internal consistency among indicators. The third stage involved evaluating the structural model (inner model) to examine the relationships among latent variables. This evaluation included several criteria: the coefficient of determination ( $R^2$ ) to measure the explanatory power of endogenous variables; predictive relevance ( $Q^2$ ) using the blindfolding procedure to assess the model's predictive capability; and the Standardized Root Mean Square Residual (SRMR) to evaluate model fit, where values below 0.10 indicate an acceptable fit. Additionally, effect size ( $f^2$ ) was considered to assess the contribution of exogenous variables to endogenous constructs. The final stage involved hypothesis testing using the bootstrapping

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technique with resampling procedures to obtain path coefficients, t-statistics, and p-values. A significance level of 5% ( $\alpha = 0.05$ ) was applied, where hypotheses are accepted if p-values are less than 0.05 and t-statistics exceed 1.96. In addition, mediation analysis was conducted to examine the role of artificial intelligence as an intervening variable. Indirect effects were tested using bootstrapping, and mediation was determined based on the significance of indirect effects. The results were then interpreted to identify whether artificial intelligence acts as a full or partial mediator in the relationship between independent variables and teacher creativity.

### 3. Results and Discussion

The validity and reliability testing of the instrument in this study was conducted in two stages. The first stage was expert validation, consisting of education experts. After passing the expert validation test, the second stage was a limited trial on respondents selected outside the research sample. After passing both validity and reliability tests, the research instrument was then distributed to the research sample respondents. A summary of the results of the analysis of the research model parameters (Inner and Outer Model) as a whole can be seen in the model diagram Figure 1 below:

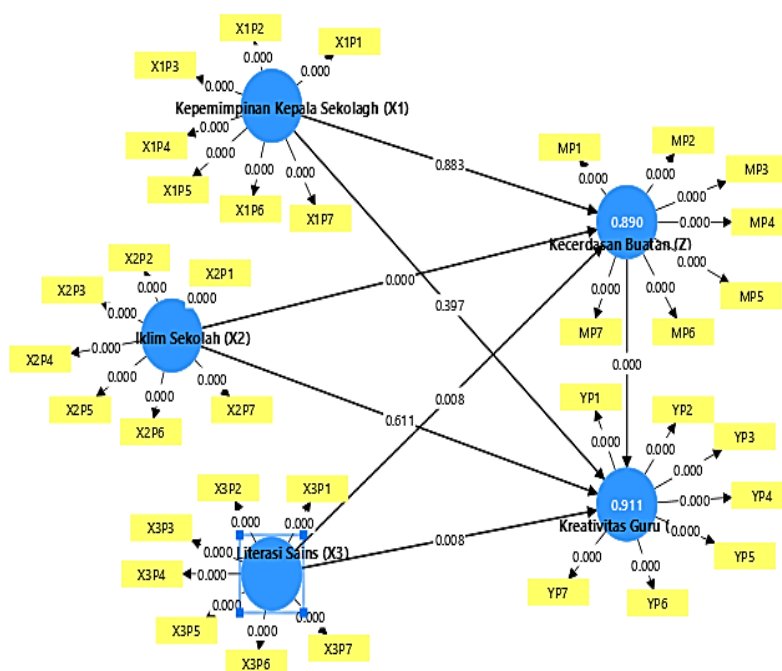


Figure 1. Model Diagram

#### Model Fit

The results of the model fit measurement of the research model with the research data can be seen in the following details:

### a. Outer Model

#### *Convergent Validity*

The outer loading values of each indicator are presented in Table 1. This analysis was conducted to evaluate the convergent validity of the measurement model by examining the extent to which each indicator reflects its respective construct.

Table 1. Outer Loading Values

Variables	Outer Loading	Criteria	Conclusion
Principal Leadership ( $X_1$ )	0,734 – 0,878	Greater than 0,5	Fit
School Climate ( $X_2$ )	0,721 – 0,858		Fit
Science Literacy ( $X_3$ )	0,906 – 0,959		Fit
Artificial Intelligence (Z)	0,732 – 0,868		Fit
Teacher Creativity (Y)	0,711 – 0,868		Fit

Source: SmartPLS

Based on Table 1, it shows that the outer loading value of all indicators of the Principal Leadership variable ( $X_1$ ), School Climate ( $X_2$ ), Science Literacy ( $X_3$ ), Artificial Intelligence (Z), and Teacher Creativity (Y) are greater than 0.5 so it can be concluded that the research model from the perspective of Convergent Validity is appropriate (Fit) meaning it can be said to be valid.

#### *Discriminant Validity*

The results of the discriminant validity analysis are presented in Table 2. This analysis was conducted to evaluate the extent to which each construct is empirically distinct, as indicated by the Average Variance Extracted (AVE) values.

Table 2. Validity Construct

Variables	Average Variance Extracted (AVE)	Criteria	Conclusion
Principal Leadership ( $X_1$ )	0,649	Greater than 0,5	Fit
School Climate ( $X_2$ )	0,627		Fit
Science Literacy ( $X_3$ )	0,861		Fit
Artificial Intelligence (Z)	0,656		Fit
Teacher Creativity (Y)	0,651		Fit

Source: SmartPLS

Based on Table 2, it shows that the outer loading value of all indicators of the Principal Leadership variable ( $X_1$ ), School Climate ( $X_2$ ), Science Literacy ( $X_3$ ), Artificial Intelligence (Z), and Teacher Creativity (Y) have Discriminant Validity which is good because it has value AVE each of which is greater than 0.5 so that it can be concluded that the research model from the perspective Discriminant Validity is appropriate (Fit) meaning it can be said to have been fulfilled.

**Composite Reliability**

The results of the composite reliability analysis are presented in Table 3. This analysis was conducted to assess the reliability and internal consistency of the measurement constructs based on the composite reliability values.

Table 3. Reliability Construct

Variables	Composite Reliability	Criteria	Conclusion
Principal Leadership (X <sub>1</sub> )	0,909	Greater than 0.7	Fit
School Climate (X <sub>2</sub> )	0,900		Fit
Science Literacy (X <sub>3</sub> )	0,973		Fit
Artificial Intelligence (Z)	0,913		Fit
Teacher Creativity (Y)	0,909		Fit

Source: SmartPLS

Based on Table 3, it shows that the outer loading value of all indicators of the Principal Leadership variable (X<sub>1</sub>), School Climate (X<sub>2</sub>), Science Literacy (X<sub>3</sub>), Artificial Intelligence (Z), and Teacher Creativity (Y) has Composite Reliability which is good because each variable has a value Composite Reliability which is greater than 0.7 so it can be concluded that the research model from the perspective Composite Reliability is appropriate (Fit) meaning it can be said to be reliable.

**b. Inner Model**

The suitability of the inner model is measured using the formula  $Q^2 = 1 - (1 - R^2) \dots (1 - R_p^2)$  where Table 4 shows that  $R^2 = R\text{-square Artificial Intelligence (Z)} = 0.890$  and  $R^2 = R\text{-square Teacher Creativity (Y)} = 0.911$  so that  $Q^2 = 1 - (1 - 0,890) (1 - 0,911) = 1 - (0,11) (0,089) = 1 - 0.00979 = 0.99021$  which is close to 1 so that it is said that the suitability of the inner model is good (Fit). Because the outer model and inner model are both proven to be appropriate (Fit), it can be concluded that the research model with the research data is appropriate (Fit).

**Coefficient of Determination (R-square)**

The results of the coefficient of determination (R-square) are presented in Table 4. This analysis was conducted to assess the extent to which the independent variables explain the variance in artificial intelligence and teacher creativity.

Table 4. Coefficient of Determination (R-square)

Dependent Variable	R-square
Artificial Intelligence (Z)	0,890
Teacher Creativity (Y)	0,911

Source: SmartPLS

Analysis of the coefficient of determination ( $R^2$ ) in Table 4 shows that artificial intelligence (Z) can be explained by the principal's leadership factors (X<sub>1</sub>), school climate (X<sub>2</sub>), science literacy (X<sub>3</sub>) of 0,890 or 89,00% while the remaining 11,00% is explained by factors other than the principal's leadership (X<sub>1</sub>), school climate

( $X_2$ ), and science literacy ( $X_3$ ). Meanwhile, teacher creativity ( $Y$ ) can be explained by the principal's leadership factors ( $X_1$ ), school climate ( $X_2$ ), and science literacy ( $X_3$ ) of 0,911 or 91,10% while the remaining 8,9% is explained by factors other than the principal's leadership ( $X_1$ ), school climate ( $X_2$ ), and science literacy ( $X_3$ ).

### **Goodness of Fit**

The results of the goodness of fit analysis are presented in Table 5. This analysis was conducted to assess the adequacy of the model by examining the SRMR values in both the saturated and estimated models.

Table 5. Goodness of Fit

	<b>Saturated model</b>	<b>Estimated model</b>
SRMR	0,094	0,094

Source: SmartPLS

Analysis of SRMR value (Standardized Root Mean Square Residual) on Goodness of Fit Table 5 shows that the SRMR value is  $0,094 < 0,10$  meaning that the model has adequate fit and very good fit, the structure of the relationship between variables in the model is acceptable based on the data.

### **Direct Influence (Direct Effect)**

Table 6 presents the results of the direct effects analysis, which aims to examine the direct influence of principal leadership, school climate, and scientific literacy on artificial intelligence and teacher creativity, as well as the direct effect of artificial intelligence on teacher creativity.

Table 6. Direct Influence (Direct Effect)

<b>Independent Variable</b>	<b>Intervening Variable</b>		<b>Dependent Variable</b>	
	<b>Artificial Intelligence (Z)</b>		<b>Teacher Creativity (Y)</b>	
	<b>Coefficient</b>	<b>p-Value</b>	<b>Coefficient</b>	<b>p-Value</b>
Principal Leadership ( $X_1$ )	0,024	0,883	0,146	0,397
School Climate ( $X_2$ )	0,596	0,000	-0,100	0,611
Science Literacy ( $X_3$ )	0,351	0,008	0,328	0,008
Artificial Intelligence (Z)	-	-	0,609	0,000

Source: SmartPLS

Based on Table 6, the analysis results show that the direct influence (direct effect) principal leadership ( $X_1$ ) on artificial intelligence (Z), principal leadership shows a positive directional relationship with artificial intelligence, as indicated by the positive coefficient value on the original sample value is positive 0,024, although the increase is not strong. However, the P Value of 0,883 which is greater than 0,05 indicates that the effect is not statistically significant. Thus, the principal's leadership is not proven to have an effect on artificial intelligence. Direct influence (direct effect) principal leadership ( $X_1$ ) on teacher creativity (Y), When principal leadership improves, teacher creativity tends to increase, as the coefficient obtained for the original sample is positive at 0,146. However, the P-value of 0,397 which is

greater than 0,05 indicates that the effect is not statistically significant. Thus, principal leadership was not found to have a statistically significant effect on teacher creativity.

Direct influence (direct effect) school climate ( $X_2$ ) to artificial intelligence ( $Z$ ), The results showed that school climate has a positive effect on artificial intelligence, with a coefficient of 0.596 on the original sample value. This result indicates a positive relationship between school climate and artificial intelligence. Furthermore, the P-value of 0.000, which is less than 0.05, indicates that the effect is statistically significant. Thus, school climate has been shown to have a positive effect on artificial intelligence. Direct influence (direct effect) school climate ( $X_2$ ) on teacher creativity ( $Y$ ), When school climate improves, teacher creativity tends to decrease, as the coefficient obtained for the original sample value is negative - 0.100. However, the P-value of 0.611, which is greater than 0.05, indicates that the effect is not statistically significant. Thus, school climate has not been proven to have an effect on teacher creativity.

Direct influence (direct effect) science literacy ( $X_3$ ) to artificial intelligence ( $Z$ ), Scientific literacy has a positive effect on artificial intelligence, with a coefficient of 0.351 on the original sample value. This result indicates that scientific literacy has a positive effect on artificial intelligence. Furthermore, the P-value of 0.008, which is less than 0.05, indicates that the effect is statistically significant. Thus, scientific literacy has been shown to have a positive effect on artificial intelligence. Direct influence (direct effect) scientific literacy ( $X_3$ ) on teacher creativity ( $Y$ ), that scientific literacy has a positive influence on teacher creativity with a coefficient on the original value The sample size was positive at 0.328.

This means scientific literacy has a positive and significant effect on teacher creativity. Furthermore, the P-value of 0.008, which is less than 0.05, indicates that the effect is statistically significant. Thus, scientific literacy has been shown to have a positive influence on teacher creativity. Direct influence (direct effect) artificial intelligence ( $Z$ ) on teacher creativity ( $Y$ ), The results showed that artificial intelligence has a positive effect on teacher creativity, with a coefficient of 0.609 on the original sample value. This means Artificial intelligence demonstrates a positive and significant effect on teacher creativity. Furthermore, the P-value of 0.000, which is less than 0.05, indicates that the effect is statistically significant. Thus, artificial intelligence has been proven to have a positive influence on teacher creativity.

### **Indirect Influence (Indirect Effect)**

The results of the indirect influence are presented in Table 7 below. This analysis was conducted to examine the mediating role of artificial intelligence in the relationship between principal leadership, school climate, and scientific literacy on teacher creativity.

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Table 7. Indirect Influence (Indirect Effect)

Path	Indirect Effect	
	Coefficient	p-Value
Principal Leadership ( $X_1$ ) → Artificial Intelligence (Z) → Teacher Creativity (Y)	0,015	0,881
School Climate ( $X_2$ ) → Artificial Intelligence (Z) → Teacher Creativity (Y)	0,363	0,007
Scientific Literacy ( $X_3$ ) → Artificial Intelligence (Z) → Teacher Creativity (Y)	0,214	0,009

Source: SmartPLS

Based on Table 7, the analysis results show that the indirect effect of principal leadership on teacher creativity through artificial intelligence has a coefficient of 0.015 and is positive. This means that increasing principal leadership that encourages an increase in artificial intelligence has a direction of influence that increases teacher creativity. However, the P-Value of 0.881, which is greater than 0.05, indicates that the indirect effect is not statistically significant. Thus, artificial intelligence is not able to significantly mediate or mediated the relationship between principal leadership and teacher creativity, or in other words, the Artificial Intelligence Variable (Z) "Does Not Play a Role" in mediating the influence of Principal Leadership ( $X_1$ ) on Teacher Creativity (Y).

The indirect effect of school climate on teacher creativity through artificial intelligence has a coefficient of 0.363 and is positive. This means that improving school climate that encourages an increase in artificial intelligence has a direction of influence that increases teacher creativity. The P-Value of 0.007, which is smaller than 0.05, indicates that the indirect effect is statistically significant. Thus, artificial intelligence is able to significantly mediate the relationship between school climate and teacher creativity, or in other words, the Artificial Intelligence Variable (Z) "Plays a Role" in mediating the influence of School Climate ( $X_2$ ) on Teacher Creativity (Y).

The indirect effect of scientific literacy on teacher creativity through artificial intelligence has a coefficient of 0.214 and is positive. This means that increasing scientific literacy that drives the increase in artificial intelligence has a direction of influence that increases teacher creativity. The P-Value of 0.009, which is smaller than 0.05, indicates that the indirect effect is statistically significant. Thus, artificial intelligence is able to significantly mediate the relationship between scientific literacy and teacher creativity, or in other words, the Artificial Intelligence Variable (Z) "Plays a role" in mediating the influence of Scientific Literacy ( $X_3$ ) on Teacher Creativity (Y).

### **Total Influence (Total Effects)**

The results of the total influence are presented in Table 8 below. This analysis aims to examine the overall influence of principal leadership, school climate, and scientific literacy on teacher creativity.

Table 8. Total Influence (Total Effects)

Variable		Total Effects	
Independent	Dependent	Coefficient	p-Value
Principal Leadership ( $X_1$ )	Teacher Creativity (Y)	0,161	0,420
School Climate ( $X_2$ )		0,263	0,163
Science Literacy ( $X_3$ )		0,541	0,000

Source: SmartPLS

Based on Table 8, the analysis results show that the total influence (total effects) principal leadership ( $X_1$ ) on teacher creativity (Y) obtained a coefficient at the original sample value of 0.161. However, the P Value of 0.420 which is greater than 0.05 indicates that the influence is not statistically significant. The total influence (total effects) school climate ( $X_2$ ) on teacher creativity (Y) obtained a coefficient at the original sample value of 0.263 positive. However, the P Value of 0.163 which is greater than 0.05 indicates that the influence is not statistically significant. The total influence (total effects) science literacy ( $X_3$ ) n teacher creativity (Y) obtained a coefficient at the original sample value of 0.541. Meanwhile, the P Value of 0.000 which is smaller than 0.05 indicates that the influence is statistically significant.

### *Hypothesis Testing*

Based on the description of the results of the SmartPLS analysis of previous research data, a summary of the findings of the hypothesis testing can be identified as follows. The results of the hypothesis testing are presented in Table 9 below:

Table 9. Model Hypothesis Testing

No.	Hypothesis	Path Coefficient	t-Value	p-Value	Hypothesis Conclusion
H <sub>1</sub>	Principal Leadership ( $X_1$ ) has a significant effect on Artificial Intelligence (Z)	0,024	0,147	0,883	Rejected
H <sub>2</sub>	School Climate ( $X_2$ ) has a significant effect on Artificial Intelligence (Z)	0,596	3,841	0,000	Accepted
H <sub>3</sub>	Science Literacy ( $X_3$ ) has a significant effect on Artificial Intelligence (Z)	0,351	2,648	0,008	Accepted
H <sub>4</sub>	Artificial Intelligence (Z) has a significant influence on Teacher Creativity (Y)	0,609	4,784	0,000	Accepted
H <sub>5</sub>	Principal Leadership ( $X_1$ ) has a significant effect on Teacher Creativity (Y)	0,146	0,847	0,397	Rejected
H <sub>6</sub>	School Climate ( $X_2$ ) has a significant effect on Teacher Creativity (Y)	-0,000	0,509	0,611	Rejected
H <sub>7</sub>	Science Literacy ( $X_3$ ) has a significant effect on Teacher Creativity (Y)	0,328	2,667	0,008	Accepted
H <sub>8</sub>	Principal Leadership ( $X_1$ ) has a significant influence on Teacher Creativity (Y) Through Artificial Intelligence (Z)	0,015	0,150	0,881	Rejected
H <sub>9</sub>	School Climate ( $X_2$ ) has a significant influence on Teacher Creativity (Y) Through Artificial Intelligence (Z)	0,363	2,712	0,007	Accepted

No.	Hypothesis	Path Coefficient	t-Value	p-Value	Hypothesis Conclusion
H <sub>10</sub>	Science Literacy (X <sub>3</sub> ) has a significant influence on Teacher Creativity (Y) Through Artificial Intelligence (Z)	0,214	2,616	0,009	Accepted

Source: SmartPLS

Based on Table 9, the results of the analysis indicate that not all proposed research hypotheses are empirically supported. The first hypothesis (H<sub>1</sub>), which proposes that principal leadership influences artificial intelligence, shows a positive path coefficient of 0.024 and a p-value of 0.883, which is greater than 0.05. This indicates that principal leadership does not have a significant direct effect on artificial intelligence; therefore, H<sub>1</sub> is rejected. Thus, principal leadership is not proven to significantly enhance artificial intelligence. The second hypothesis (H<sub>2</sub>), which examines the effect of school climate on artificial intelligence, yields a positive path coefficient of 0.596 and a p-value of 0.000, which is less than 0.05. This indicates that H<sub>2</sub> is accepted, meaning that school climate has a significant direct effect on artificial intelligence.

The third hypothesis (H<sub>3</sub>), which proposes that scientific literacy significantly affects artificial intelligence, shows a positive path coefficient of 0.351 and a p-value of 0.008, which is less than 0.05. Therefore, H<sub>3</sub> is accepted, indicating that scientific literacy has a significant positive effect on artificial intelligence. The fourth hypothesis (H<sub>4</sub>), which examines the effect of artificial intelligence on teacher creativity, yields a positive path coefficient of 0.609 and a p-value of 0.000, which is less than 0.05. Thus, H<sub>4</sub> is accepted, indicating that artificial intelligence has a significant positive effect on teacher creativity. The fifth hypothesis (H<sub>5</sub>), which proposes that principal leadership significantly affects teacher creativity, shows a positive path coefficient of 0.146 and a p-value of 0.397, which is greater than 0.05. Therefore, H<sub>5</sub> is rejected, indicating that principal leadership does not have a significant effect on teacher creativity. The sixth hypothesis (H<sub>6</sub>), which examines the effect of school climate on teacher creativity, yields a path coefficient of -0.000 and a p-value of 0.611, which is greater than 0.05. Thus, H<sub>6</sub> is rejected, indicating that school climate does not have a significant effect on teacher creativity.

The seventh hypothesis (H<sub>7</sub>), which proposes that scientific literacy significantly affects teacher creativity, shows a positive path coefficient of 0.328 and a p-value of 0.008, which is less than 0.05. Therefore, H<sub>7</sub> is accepted, indicating that scientific literacy has a significant positive effect on teacher creativity. The eighth hypothesis (H<sub>8</sub>), which examines the effect of principal leadership on teacher creativity through artificial intelligence, yields a positive path coefficient of 0.015 and a p-value of 0.881, which is greater than 0.05. Thus, H<sub>8</sub> is rejected, indicating that artificial intelligence does not significantly mediate the relationship between principal leadership and teacher creativity.

The ninth hypothesis (H<sub>9</sub>), which proposes that school climate affects teacher creativity through artificial intelligence, shows a positive path coefficient of 0.363 and a p-value of 0.007, which is less than 0.05. Therefore, H<sub>9</sub> is accepted, indicating

that artificial intelligence significantly mediates the relationship between school climate and teacher creativity. The tenth hypothesis ( $H_{10}$ ), which examines the effect of scientific literacy on teacher creativity through artificial intelligence, yields a positive path coefficient of 0.214 and a p-value of 0.009, which is less than 0.05. Thus,  $H_{10}$  is accepted, indicating that artificial intelligence significantly mediates the relationship between scientific literacy and teacher creativity.

### ***The Influence of Principal Leadership ( $X_1$ ) on Artificial Intelligence ( $Z$ )***

Principal Leadership ( $X_1$ ) has a positive but insignificant effect on artificial intelligence directly. The results of the hypothesis test show that principal leadership does not have a significant effect on artificial intelligence with a coefficient of 0,024; t-value 0,147; p-value 0,883. This finding indicates that principal leadership has not been able to directly encourage the use of artificial intelligence in the school environment. Conceptually, this is in line with findings in digital transformation studies which state that conventional leadership does not automatically result in AI implementation without specific digital competencies and leadership strategies where only certain dimensions contribute significantly to technology adoption in the context of school AI (Pietsch & Kristin, 2025). Systematic reviews show that principal digital leadership can indeed improve teachers' ability to adopt AI, but leadership alone is not the sole determining factor without the support of a school culture and adequate professional support (Zeng et al., 2025).

### ***The Influence of School Climate ( $X_2$ ) on Artificial Intelligence ( $Z$ )***

School Climate ( $X_2$ ) has a significant positive effect on Artificial Intelligence ( $Z$ ) directly. The results of the analysis show that school climate has a positive and significant effect on artificial intelligence with a path coefficient of 0.596; t-value of 3.841; p-value of 0.000, which indicates that a conducive, collaborative, and open school environment towards innovation plays a significant role in encouraging the use of technology such as artificial intelligence. This finding is in line with studies showing that a supportive school climate increases the integration of digital technology in educational practices, because schools that have a collaborative culture, structural support, and digital readiness tend to accelerate the adoption of educational technology, including AI (Liu et al., 2025). Furthermore, longitudinal results show that a school's innovative climate positively influences the acceptance of educational technology, including perceptions of the technology's usefulness and ease of use, reinforcing the role of school climate in effectively accelerating the adoption of digital technology (Kaewsang et al., 2022). Other empirical evidence also suggests that school conditions that support and facilitate information and communication technology strengthen the relationship between school climate and technology use in learning practices (Cabellos et al., 2024).

### ***The Influence of Science Literacy ( $X_3$ ) on Artificial Intelligence ( $Z$ )***

Science Literacy ( $X_3$ ) has a significant positive effect on Artificial Intelligence ( $Z$ ) directly. The results of the study show that scientific literacy has a positive and

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significant effect on artificial intelligence with a coefficient of 0.351; t-value of 2.648; p-value of 0.008, which indicates that teachers with high levels of scientific literacy tend to be more prepared and able to utilize artificial intelligence in learning. This finding is supported by research showing that knowledge and acceptance of technologies such as AI are important factors in the use of artificial intelligence in science teaching, where teachers who have technological literacy tend to be more active in adopting AI in their classroom practices (Nja et al., 2023). In addition, a systematic literature review found that the integration of AI in science learning can improve students' digital literacy, which indicates the role of scientific/technological literacy in supporting the effective use of AI in learning (Wardhani et al., 2025). Other research also shows that digital literacy contributes to openness and acceptance of AI in educational environments, so strong scientific literacy can facilitate the use of AI as a learning tool (Michael et al., 2024). Furthermore, studies on AI literacy in education confirm that the ability to understand and use AI is a key competency for educators to maximize the potential of this technology in learning, which is in line with the finding that science literacy plays a significant role in the adoption of artificial intelligence in schools (Sperling et al., 2024).

### ***The Influence of Artificial Intelligence (Z) on Teacher Creativity (Y)***

Artificial Intelligence (Z) has a significant positive effect on Teacher Creativity (Y) directly. The test results show that artificial intelligence has a positive and significant effect on teacher creativity with a path coefficient of 0.609; a t-value of 4.784; and a p-value of 0.000, indicating that the use of AI helps teachers develop innovative learning ideas, personalize materials, and vary teaching methods. These findings align with research showing that the integration of AI tools in teacher education can enhance their creative abilities in designing and implementing learning strategies through innovative instructional recommendations and pedagogical support (Alasgarova & Rzayev, 2025). A systematic review of the use of AI in teaching and professional development confirms the potential of AI as a driver of pedagogical innovation and creative thinking for teachers in the context of the digital transformation of education.

Artificial intelligence also supports instructional innovation by enhancing facilitation processes and leadership capacity in schools. Previous studies emphasize that effective facilitation and leadership development are essential to support innovation and creative teaching practices (Afwanudin et al., 2026; Husna et al., 2026). Which in turn fosters teacher creativity and encourages the meaningful integration of artificial intelligence in teaching and learning processes. Other research also shows that teachers' use of AI in the learning process also enhances student creativity through adaptive feedback and higher learning engagement, which has implications for increasing teacher creativity in selecting more effective and differentiated learning strategies (Zhou & Peng, 2025). Furthermore, the integration of AI that offers adaptive and personalized learning at the classroom level motivates teachers to create materials and methods that are more dynamic and responsive to students' needs, thereby strengthening pedagogical creativity (Revenaya, 2025).

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### ***The Influence of Principal Leadership (X<sub>1</sub>) on Teacher Creativity (Y)***

Principal Leadership (X<sub>1</sub>) as a positive but insignificant effect on Teacher Creativity (Y) directly. The results of the analysis show that principal leadership does not have a significant effect on teacher creativity with a coefficient of 0.146; t-value of 0.847; p-value of 0.397, indicating that teacher creativity is not solely determined by the principal's leadership style, but is more influenced by other individual and work environment factors. This finding is in accordance with research showing that the role of leadership in encouraging teacher creativity does not always automatically have a significant impact, depending on the dimensions of leadership applied and the school organizational context, for example, instructional versus innovative leadership that interacts with school culture and professional support (Tahir et al., 2024).

Transformational leadership by the principal has been proven to enhance teachers' professionalism, discipline, and creativity in carrying out the learning process, while also creating a work environment that supports teacher innovation and professional development (Baharu et al., 2026). Other research also shows that principal leadership contributes to teacher creativity, but its contribution is relatively small compared to other factors such as teacher professionalism and work motivation, which implies that leadership alone is not enough to significantly encourage creativity without the support of internal teacher factors (Samosir et al., 2023). In addition, studies examining the influence of leadership style on innovative work behaviours Teachers found that leadership can influence innovation, but this influence depends on the context and how leadership is implemented in school practices, so that the direct effect on teacher creativity is often insignificant if other supporting factors are not optimal (Khaola & Resource, 2019).

### ***The Influence of School Climate (X<sub>2</sub>) on Teacher Creativity (Y)***

School Climate (X<sub>2</sub>) as a negative and insignificant effect on Teacher Creativity (Y) directly. The results of the study indicate that school climate has a negative and insignificant effect on teacher creativity with a path coefficient of -0.000; t-value of 0.509; p-value of 0.611, which means that even though the school climate is conducive, it does not necessarily directly trigger teacher creativity if other contextual factors do not support it. This finding differs from many previous studies that research in the context of elementary education shows that school climate can contribute to teacher creativity if supported by instructional leadership and other supporting components such as scientific literacy or principal service leadership, so the direct effect of school climate alone is not always significant (Fabiana, 2023). In addition, other studies suggest that teacher creativity increases when school climate interacts with other factors such as scientific literacy and strong leadership support, which suggests that school climate needs to be combined with other factors to truly encourage creativity, for example increasing teacher competence in utilizing technology or improving school policies towards innovation (Yuliani et al., 2025).

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### ***The Influence of Science Literacy (X<sub>3</sub>) on Teacher Creativity (Y)***

Science Literacy (X<sub>3</sub>) has a significant positive effect on Teacher Creativity (Y) directly. The test results show that scientific literacy has a positive and significant effect on teacher creativity with a path coefficient of 0.328; t-value 2.667; p-value 0.008), which confirms that teachers with good scientific literacy have higher critical thinking and problem-solving skills, thus encouraging creativity in learning. This finding is consistent with empirical evidence showing that increasing scientific literacy significantly contributes to increasing teacher creativity, where scientific literacy is an important asset for teachers in developing creative learning ideas, integrating scientific concepts into classroom practices, and creating innovative learning strategies (Fabiana, 2023). In addition, this study is in line with other studies that suggest that teacher creativity increases with the support of scientific literacy possessed by teachers (Yuliani et al., 2025).

### ***The Influence of Principal Leadership (X<sub>1</sub>) on Teacher Creativity (Y) Through Artificial Intelligence (Z)***

Principal Leadership (X<sub>1</sub>) has a positive but insignificant effect on Teacher Creativity (Y) Through Artificial Intelligence (Z). The results of the analysis show that artificial intelligence is unable to mediate the influence of principal leadership on teacher creativity with a path coefficient of 0.015; t-value of 0.150; p-value of 0.881 which indicates that the role of principal leadership in encouraging teacher creativity through the use of AI is still not optimal. This finding can be understood from the literature stating that digital leadership that supports AI integration does not always automatically become a pedagogical action that triggers teacher creativity without other contextual support such as teacher trust in AI, professional training, and policy support (Hsieh et al., 2026). In addition, a systematic review of the role of principal digital leadership in the adoption of AI technology shows that effective leadership includes the provision of resources, training, and ongoing support without these elements, the ability of AI to function as a direct mediator of teacher creativity is limited (Zeng et al., 2025). Other quantitative research also suggests that while AI can enhance teacher innovation in some contexts, the effects are more complex than a simple mediation pathway, and depend on contextual factors as well as organizational readiness to use the technology meaningfully (Guo et al., 2025).

### ***The Influence of School Climate (X<sub>2</sub>) on Teacher Creativity (Y) Through Artificial Intelligence (Z)***

School Climate (X<sub>2</sub>) has a significant positive effect on Teacher Creativity (Y) through Artificial Intelligence (Z). The results of the study indicate that artificial intelligence significantly mediates the effect of school climate on teacher creativity with a path coefficient = 0.363; t-value = 2.712; p-value = 0.007, which illustrates that a conducive school climate will be more effective in increasing teacher creativity if supported by the use of artificial intelligence in educational practices. Theoretically, an innovative school climate encourages teachers to engage in professional development and the adoption of educational technology, which then

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strengthens the use of digital tools in learning and the creation of new pedagogical ideas, including artificial intelligence as a catalyst for creativity (Baog et al., 2025). In addition, research related to the school innovation climate and the adoption of educational technology shows that a positive school climate significantly increases teacher readiness and use of technology, thus providing greater space for This technology functions as a mediator in the process of professional innovation, including teaching creativity (Kaewsaeng et al., 2022). In line with this research, evidence from other studies adopting a social cognitive theory framework also supports that the use of educational technology, including AI, plays an important mediating role between the innovative climate conditions of the learning environment and the creativity generated by educators (Jiang et al., 2025).

### ***The Influence of Science Literacy ( $X_3$ ) on Teacher Creativity (Y) Through Artificial Intelligence (Z)***

Science Literacy ( $X_3$ ) has a significant positive effect on Teacher Creativity (Y) through Artificial Intelligence (Z). The results of the analysis show that artificial intelligence significantly mediates the effect of scientific literacy on teacher creativity with a path coefficient = 0.214; t-value = 2.616; p-value = 0.009 which illustrates that high scientific literacy allows teachers to utilize artificial intelligence optimally to develop teacher creativity in learning. This finding is in line with the literature showing that the integration of AI in science teaching and digital literacy as a whole can strengthen critical thinking and problem-solving skills, which are important elements in pedagogical innovation. For example, a systematic review found that AI improves scientific digital literacy that supports the use of adaptive and interactive learning techniques conditions that open space for teacher creativity in designing meaningful learning experiences (Wardhani et al., 2025). In addition, exploration of the literature on teacher AI literacy shows that teachers' attitudes, motivations, and readiness towards AI technology are important predictors in their ability to effectively integrate AI in creative teaching practices. Teachers with strong scientific and AI literacy tend to be better able to utilize AI tools to structure materials, respond to student needs, and develop creative and innovative learning approaches (Dehen et al., 2026). Other research studies on the role of AI in teacher professional development also reinforce the view that the combination of scientific literacy, pedagogical skills, and AI utilization is key to fostering educational creativity, so that AI exists not only as a technological tool but also as a supporter in reflective and innovative teaching processes (Tan et al., 2025).

The findings indicate that principal leadership and school climate do not have a statistically significant direct effect on teacher creativity. However, both variables demonstrate indirect influence through artificial intelligence, suggesting that technological integration plays a crucial mediating role in enhancing teacher creativity. In line with this, the results of this study show that principal leadership has a positive but not statistically significant effect on teacher creativity, as indicated by a positive path coefficient with a p-value greater than 0.05, leading to the rejection of the hypothesis. This implies that although effective principal leadership tends to support teacher creativity, its direct impact is not sufficient without the support of other factors, particularly technological integration.

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Furthermore, school climate was also found to have no significant direct effect on teacher creativity. Although a conducive, collaborative, and supportive school environment theoretically contributes to increasing teacher motivation and openness to innovation, the findings of this study suggest that such an environment does not automatically translate into higher teacher creativity. Instead, its influence becomes meaningful when supported by the use of artificial intelligence, which acts as a mediating variable in transforming organizational support into innovative teaching practices. In contrast, scientific literacy was found to have a positive and statistically significant direct effect on teacher creativity. Teachers with strong scientific literacy are better equipped to develop problem-solving-based and contextual learning, thereby enhancing their ability to design creative instructional strategies. These findings are consistent with the concept of 21st-century education, which emphasizes the importance of literacy as a foundation for higher-order thinking skills, including creativity. Thus, while leadership and school climate require technological mediation to influence creativity, scientific literacy serves as a direct and essential driver of teacher creativity.

An interesting finding in this study is the role of artificial intelligence as an intervening variable that strengthens the relationship between the independent variables and teacher creativity. The analysis results show that artificial intelligence can be a significant mediator in enhancing teacher creativity, especially in supporting technology-based learning processes. This indicates that the use of artificial intelligence-based technology is not only technical, but also strategic in improving the quality of learning. This finding strengthens the view that technology integration in education can be a catalyst in increasing pedagogical innovation. Theoretically, this study contributes to enriching the study of the relationship between educational leadership, school climate, scientific literacy, and teacher creativity by placing artificial intelligence as an intervening variable. The resulting model shows that teacher creativity is not only influenced by internal and organizational factors, but also by technological factors as a reinforcing variable. Thus, this study broadens the perspective in the study of educational management, particularly in the context of digital transformation.

Practically, the results of this study provide important implications for educational administrators, particularly school principals, to further optimize the role of leadership in encouraging teacher creativity by creating a conducive school climate and utilizing artificial intelligence-based technology. Furthermore, improving teachers' scientific literacy should be a priority in professional development, enabling them to produce innovative and relevant learning that meets the demands of the times. Therefore, educational policy needs to be directed at integrating leadership, the school environment, literacy, and technology as a whole to improve the quality of education.

#### **4. Conclusion**

This study provides a conceptual understanding of 21st-century education by emphasizing that teacher creativity in the digital transformation era is shaped by the

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interaction between individual capacity, organizational environment, and technological integration. The findings confirm that artificial intelligence (AI) acts as a mediating variable that strengthens the transformation of leadership and school climate into innovative teaching practices. Although principal leadership and school climate do not have a statistically significant direct effect on teacher creativity, both variables contribute indirectly through AI, highlighting the importance of technological integration in fostering creativity. In contrast, scientific literacy has a direct and statistically significant effect on teacher creativity, indicating its crucial role in supporting meaningful and innovative learning practices. Overall, this study positions AI as a catalyst for enhancing teacher creativity, particularly when supported by teachers' professional competencies and effective technology utilization. These findings suggest that efforts to improve teacher creativity should focus not only on leadership and school climate but also on strengthening scientific literacy and the integration of AI in learning processes. Future research is recommended to involve a broader regional scope and a larger number of respondents to obtain more comprehensive findings. In addition, the AI variable in this study was measured in general terms and did not specifically examine the type, intensity, and form of its use in learning. This limitation provides opportunities for further research to explore the role of AI in a more specific and in-depth manner.

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