



Examining the Effect of Principals's Transformational Leadership and School Work Climate on Deep Learning Implementation

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Abstract

The implementation of deep learning has become a strategic priority in Indonesia's educational reform under the Merdeka Curriculum, emphasizing meaningful, reflective, and student-centered learning. However, its successful implementation depends on school leadership and organizational conditions that support teachers in adopting innovative pedagogical practices. This study examined the effects of principals' transformational leadership and school work climate on the implementation of deep learning in public elementary schools in Talun District, Pekalongan Regency. A quantitative explanatory survey design was employed involving 114 teachers selected through proportional simple random sampling from a population of 162 teachers across 21 public elementary schools. Data were collected using Likert-scale questionnaires and analyzed through descriptive statistics, Pearson correlation, simple and multiple linear regression using IBM SPSS Statistics. The findings revealed that principals' transformational leadership had a positive and significant effect on deep learning implementation, explaining 58.2% of its variance, while school work climate contributed 50.7%. Simultaneously, both variables explained 78.1% of the variance, with transformational leadership emerging as the stronger predictor. These findings indicate that effective implementation of deep learning requires not only teachers' pedagogical competence but also transformational school leadership and a supportive work climate that foster collaboration, innovation, and continuous professional learning. The study provides empirical evidence that strengthening school leadership and improving organizational climate are essential strategies for promoting sustainable pedagogical transformation and improving the quality of elementary education.

Introduction

Educational transformation in the twenty-first century has shifted the focus of learning from knowledge acquisition toward the development of higher-order thinking skills, creativity, collaboration, communication, and complex problem-solving abilities. This transformation has been accelerated by rapid technological advancement, the Fourth Industrial Revolution, and Society 5.0, requiring schools to prepare learners who are adaptive, innovative, and capable of lifelong learning. Consequently, educational quality is increasingly evaluated not by the volume of knowledge transmitted but by students' ability to construct conceptual understanding, apply knowledge in authentic contexts, and solve problems critically and reflectively (Weng et al., 2023; Woods & Copur-Gencturk, 2024; Richardson et al., 2024). In response to these demands, educational systems worldwide have prioritized instructional transformation that promotes meaningful learning and the development of twenty-first-century competencies.

This global trend is reflected in Indonesia through the implementation of the Merdeka Curriculum, which promotes student-centered, contextual, collaborative, and competency-based learning. Within this framework, deep learning has emerged as a strategic instructional approach that enables students to construct meaningful understanding through inquiry, reflection, collaboration, and authentic problem-solving (Sliwka et al., 2024; Umpstead, 2024; Heuteij, 2024). Unlike *surface learning*, which emphasizes memorization and information reproduction, *deep learning* encourages students to analyze, evaluate, synthesize, and transfer knowledge across different situations, thereby fostering sustainable learning and long-term competency development. Empirical studies consistently demonstrate that *deep learning* enhances students' critical thinking, creativity, learning motivation, self-regulated learning, and knowledge transfer by engaging them in authentic and collaborative learning experiences (Weng et al., 2023; Tang et al., 2025; Woods & Copur-Gencturk, 2024).

Despite these advantages, implementing *deep learning* remains challenging, particularly in elementary schools where instructional practices often continue to emphasize teacher-centered instruction and curriculum completion rather than meaningful knowledge construction. Such conditions indicate that pedagogical transformation requires more than changes in classroom instruction; it also depends on organizational capacity that supports continuous innovation and professional learning (Schmitz et al., 2023; Hsieh et al., 2024; Hardianto et al., 2024; Nellitawati et al., 2024). Accordingly, the successful implementation of *deep learning* requires a supportive school ecosystem characterized by effective leadership, collaborative professional culture, and organizational conditions that encourage teachers to innovate continuously (Patfield et al., 2023; Richardson et al., 2024).

Educational transformation toward *deep learning* requires teachers to move beyond their traditional role as knowledge transmitters and become facilitators who design meaningful learning experiences through inquiry, reflection, collaboration, and authentic problem-solving. However, previous studies indicate that this transition has not yet been fully achieved because many teachers continue to experience difficulties in shifting from conventional instruction to student-centered learning due to limited pedagogical competence, weak professional collaboration, and insufficient organizational support for instructional innovation (Bentri et al., 2025; Zamsiswaya et al., 2024; Hidayati et al., 2023; Yolviansyah et al., 2024). These findings suggest that the successful implementation of *deep learning* depends not only on teachers' individual competencies but also on organizational conditions that facilitate instructional change.

Among the organizational factors influencing instructional transformation, principals' transformational leadership has been widely recognized as a critical driver of educational improvement. Transformational principals establish a shared vision, inspire teachers, encourage continuous professional learning, and create opportunities for instructional innovation through *idealized influence*, *inspirational motivation*, *intellectual stimulation*, and *individualized consideration* (Sliwka et al., 2024; Schmitz et al., 2023; Wang, 2024). Previous studies have demonstrated that transformational leadership strengthens organizational commitment, job satisfaction, creativity, innovative work behavior, and teachers' readiness to adopt instructional change (Efendi et al., 2023; Restiani et al., 2024; Hardianto et al., 2024; Hardianto et al., 2025; Laursen et al., 2025). Furthermore, integrating transformational and instructional leadership has been shown to foster school cultures that support sustainable instructional improvement and meaningful learning (Nellitawati et al., 2024; Yuliana et al., 2025; Richardson et al., 2024).

In addition to leadership, the school work climate plays an essential role in supporting teachers' implementation of *deep learning*. A positive work climate is reflected in supportive interpersonal relationships, effective communication, psychological safety, collaborative opportunities, and organizational appreciation for creativity and innovation (Komariah et al., 2023; Rumengan & Idawati, 2024; Yolviansyah et al., 2024). Such conditions encourage teachers to experiment with innovative instructional practices, whereas rigid organizational environments often discourage pedagogical change. International evidence further confirms that school climate significantly influences teachers' creativity, professional collaboration, self-efficacy, job satisfaction, and the successful implementation of educational innovation (Hsieh et al., 2024; Da'as, 2023; Hu & Li, 2024; Liu et al., 2025; Jiang et al., 2025; Almessabi & Alhosani, 2024; Zhou et al., 2026). These findings indicate that transformational leadership and a supportive school work climate are complementary organizational capacities that strengthen schools' readiness to implement *deep learning* effectively.

Preliminary findings from public elementary schools in Talun District, Pekalongan Regency, indicate that *deep learning* has begun to be implemented; however, its quality and consistency vary considerably across schools. While some teachers have adopted project-based learning, collaborative discussions, and reflective learning activities, others continue to rely primarily on teacher-centered instruction and content-oriented teaching. Similar variations are also evident in principals' leadership practices and school work climates, which appear to influence teachers' readiness to implement *deep learning*. Preliminary data further reveal that transformational leadership, school work climate, and *deep learning* implementation remain at a moderately developed level, suggesting that these organizational capacities have not yet been fully optimized to support instructional transformation. These conditions highlight the need for empirical evidence regarding organizational factors that facilitate the implementation of *deep learning* in Indonesian elementary schools.

Although previous studies have extensively examined the relationships between transformational leadership, organizational climate, teacher performance, job satisfaction, organizational commitment, and innovative work behavior, limited attention has been given to their direct contribution to the implementation of *deep learning*, particularly in elementary education (Werang et al., 2023; Sucitra et al., 2024; Maharani et al., 2025; Prasetyono et al., 2024). Moreover, most international studies have conceptualized *deeper learning* within developed-country educational systems, leaving insufficient empirical evidence from developing countries with different organizational, cultural, and policy contexts (Umpstead, 2024; Aydın et al., 2025; Richardson et al., 2024). To the best of the authors' knowledge, no previous study has simultaneously examined the effects of principals' transformational leadership and school work climate on the implementation of *deep learning* in Indonesian public elementary schools.

Accordingly, this study aims to examine the effects of principals' transformational leadership and school work climate, both individually and simultaneously, on the implementation of *deep learning* in public elementary schools in Talun District, Pekalongan Regency. The findings are expected to extend the literature on educational leadership and school organizational climate by providing an empirical model that explains organizational determinants of *deep learning*. Furthermore, the study offers practical recommendations for school leaders and education policymakers to strengthen leadership practices and create supportive school environments that foster sustainable pedagogical transformation and improve the quality of elementary education.

Methods

This study employed a quantitative approach using an explanatory survey design to examine the effects of principals' transformational leadership and school work climate on the implementation of deep learning in public elementary schools. The explanatory survey design was selected because it enables the examination of relationships among variables through statistical analysis based on empirical data collected from respondents. The study was conducted in 21 public elementary schools in Talun District, Pekalongan Regency, Indonesia, all of which have implemented the Merdeka Curriculum. The research setting was selected because the schools share similar curriculum characteristics while demonstrating variations in principals' leadership practices, school work climate, and deep learning implementation.

The study population consisted of 162 teachers from 21 public elementary schools. The sample size was determined using the Krejcie and Morgan sampling formula, resulting in 114 teachers. Respondents were selected using proportional simple random sampling. The proportional allocation procedure was conducted by calculating the proportion of teachers in each school compared with the total population. The number of respondents selected from each school was determined using the formula (number of teachers in each school / total population × total sample size). After proportional allocation was determined, teachers from each school were selected randomly to ensure that every teacher had an equal opportunity to participate.

The study involved two independent variables and one dependent variable. The first independent variable was principals' transformational leadership, operationalized through four dimensions: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. The measurement indicators were developed and adapted from Bass and Avolio's (1994) transformational leadership theory, particularly the Four I's model of transformational leadership. This framework explains transformational leadership through leaders' ability to become role models (idealized influence), develop shared vision and motivation (inspirational motivation), stimulate creativity and critical thinking (intellectual stimulation), and provide individual support for followers' development (individualized consideration). The principals' transformational leadership instrument consisted of 36 questionnaire items.

The second independent variable was school work climate, measured through four dimensions: psychological, structural, social, and bureaucratic dimensions. The indicators were adapted from educational organizational climate perspectives emphasizing teachers' perceptions of psychological conditions, organizational structures, social relationships, communication, and administrative systems within schools. The school work climate instrument consisted of 33 questionnaire items.

The dependent variable was the implementation of deep learning, assessed through five dimensions: cognitive engagement, affective engagement, active involvement, higher-order thinking skills, and knowledge transfer. The indicators were developed based on deeper learning frameworks that emphasize meaningful learning processes, reflection, collaboration, higher-order thinking, problem solving, and the ability to transfer knowledge into authentic contexts (Richardson et al., 2024; Sliwka et al., 2024). The deep learning implementation instrument consisted of 45 questionnaire items.

Data were collected using a five-point Likert-scale questionnaire ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire items were developed based on the operational indicators of each construct and reviewed through expert judgment to establish content validity. The content validation process involved two experts, namely Prof. Dr.

Senowarsito, M.Pd. and Prof. Dr. Harjito, M.Hum., who have expertise in educational management and educational research. The experts evaluated the relevance, clarity, language appropriateness, and theoretical alignment of each item. Suggestions provided by the validators were incorporated to improve the quality of the instrument before empirical testing.

The pilot study involved 30 teachers who were not included in the research sample. The validity test indicated that all questionnaire items exceeded the critical r-value (0.361) and were considered valid. The validity testing showed that all 45 items of deep learning implementation, 36 items of transformational leadership, and 33 items of school work climate met the validity criteria. Reliability testing using Cronbach's alpha demonstrated excellent internal consistency, with coefficients of 0.995 for deep learning implementation, 0.991 for principals' transformational leadership, and 0.990 for school work climate.

Considering the exceptionally high Cronbach's alpha coefficients, additional examination was conducted to ensure that the items did not contain substantial redundancy. The authors reviewed the conceptual similarity among items and item-total relationships to confirm that each item represented a distinct aspect of the measured construct rather than measuring identical content repeatedly.

Data collection was conducted by distributing printed questionnaires directly to selected teachers in the 21 participating schools. The completed questionnaires were collected directly by the researcher after completion. Participation was voluntary, and respondents were informed regarding the purpose of the study, confidentiality of responses, and their right to refuse participation. Informed consent was obtained from all respondents before completing the questionnaire.

Data analysis was performed using IBM SPSS Statistics version 25. The first stage involved descriptive statistical analysis to summarize the research variables using mean, standard deviation, minimum, and maximum values. Pearson correlation analysis was conducted to examine the relationship between principals' transformational leadership and deep learning implementation, as well as between school work climate and deep learning implementation. Simple linear regression analysis was also conducted to determine the individual effect of each independent variable on deep learning implementation. Multiple linear regression analysis was subsequently applied to examine the simultaneous effect of principals' transformational leadership and school work climate on deep learning implementation.

Before hypothesis testing, regression assumption testing was conducted. The assumption tests included normality of regression residuals, linearity, multicollinearity, homoscedasticity, and independence of residuals. Normality testing was conducted using regression residuals rather than raw variable scores. Homoscedasticity testing was performed to examine whether residual variance remained constant across predicted values, while independence of residuals was assessed using the Durbin–Watson statistic. The significance of individual effects was assessed using the t-test, whereas the overall regression model was evaluated using the F-test at a significance level of 0.05. The explanatory power of the regression model was determined using the coefficient of determination (R^2).

Because respondents were distributed across 21 different schools, potential clustering effects among teachers within schools were considered. However, the present study analyzed data at the individual teacher level using conventional regression analysis. Therefore, possible school-level influences cannot be completely excluded and are acknowledged as a methodological limitation. Future studies are recommended to apply multilevel analysis to examine teacher-level and school-level effects simultaneously.

Results and Discussion

This section presents the findings of the data analysis regarding the effects of principals' transformational leadership and school work climate on the implementation of *deep learning* in public elementary schools in Talun District, Pekalongan Regency. The results are organized into descriptive statistics, regression assumption testing, and hypothesis testing through simple and multiple linear regression analyses to explain the empirical relationships among the research variables.

Descriptive Statistics of the Research Variables

Descriptive statistics were employed to provide an overview of the distribution of each research variable based on the mean, standard deviation, minimum value, and maximum value. These statistics offer an initial description of principals' transformational leadership, school work climate, and the implementation of *deep learning* as perceived by the respondents. The descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics of the Research Variables

Variables	N	Minimum	Maximum	Mean	SD	Category
Principals' Transformational Leadership	114	103	209	160.63	20.92	Moderately High
School Work Climate	114	75	175	126.39	21.47	Moderately High
Deep Learning Implementation	114	78	160	116.57	16.28	Moderately High

Source: Research data analysis, 2026

As shown in Table 1, all three research variables were classified within the moderately high category. Principals' transformational leadership obtained the highest mean score, whereas the implementation of *deep learning* demonstrated the greatest variability, as indicated by its standard deviation. These findings suggest that although transformational leadership and school work climate have been relatively well established, the implementation of *deep learning* has not yet been consistently practiced across all elementary schools.

To verify the classification of respondents into the categories of very low, low, moderately high, high, and very high, score intervals were calculated based on the possible minimum and maximum scores of each instrument. The interval width was determined using the formula: (maximum score-minimum score) divided by five categories. These intervals were then used as the basis for categorizing respondents' scores across the three research variables.

Regression Assumption Testing

Prior to hypothesis testing, the data were examined to ensure compliance with the assumptions of multiple linear regression, including normality, linearity, and multicollinearity. Meeting these assumptions is essential to obtain unbiased and reliable parameter estimates. The results are presented in Table 2.

Table 2. Results of the Regression Assumption Tests

Assumption	Indicator	Result	Interpretation
Normality	Kolmogorov–Smirnov Sig.	0.062	Normal
Linearity ($X_1 \rightarrow Y$)	Deviation from Linearity	0.455	Linear
Linearity ($X_2 \rightarrow Y$)	Deviation from Linearity	0.182	Linear
Multicollinearity (X_1)	Tolerance = 0.842; VIF = 1.187		Not detected
Multicollinearity (X_2)	Tolerance = 0.842; VIF = 1.187		Not detected

Source: Research data analysis, 2026

The results in Table 2 indicate that all regression assumptions were fulfilled. The normality test was conducted using regression residuals rather than raw variable scores. The Kolmogorov–Smirnov result indicated that the residuals were normally distributed because the significance value exceeded 0.05. The linearity tests showed linear relationships between each independent variable and deep learning implementation. Multicollinearity was not detected because the Tolerance values were above 0.10 and VIF values were below 10.

Hypothesis Testing

Hypothesis testing was conducted to examine the effects of principals' transformational leadership and school work climate on the implementation of *deep learning*. The analysis began by assessing the individual contribution of each independent variable using simple linear regression.

Pearson correlation analysis was conducted to examine the strength and direction of the relationship between each independent variable and deep learning implementation. In addition, simple linear regression analysis was conducted to determine the contribution of each independent variable to deep learning implementation. The results are summarized in Table 3.

Table 3. Results of the Partial Effect Analysis

Variables	B	t	Sig.	R ²
Transformational Leadership → Deep Learning	0.763	12.828	0.000	0.582
School Work Climate → Deep Learning	0.712	11.006	0.000	0.507

Source: Research data analysis, 2026

In the previous version, the values 0.763 and 0.712 were presented as β coefficients. These values are clarified here as Pearson correlation coefficients (r), while the t -values and R^2 values represent the results of the simple linear regression analysis. As shown in Table 3, both principals' transformational leadership and school work climate had positive and statistically significant effects on the implementation of *deep learning* ($p < .001$). The coefficient of determination indicates that transformational leadership explained 58.2% of the variance in *deep learning* implementation, whereas school work climate accounted for 50.7%. The remaining variance was attributable to other factors beyond the scope of this study. To examine the simultaneous effects of both independent variables, multiple linear regression analysis was subsequently performed. The results are presented in Table 4.

Table 4. Results of the Multiple Linear Regression Analysis

R	R²	Adjusted R²	F	Sig.
0.884	0.781	0.777	208.116	0.000

Source: Research data analysis, 2026

The results presented in Table 4 indicate that principals' transformational leadership and school work climate jointly exerted a positive and statistically significant effect on the implementation of *deep learning*. The standardized regression coefficients further revealed that transformational leadership contributed more strongly than school work climate to the implementation of *deep learning*. Moreover, the coefficient of determination ($R^2 = 0.781$) indicates that the two independent variables collectively explained 78.1% of the variance in *deep learning* implementation, whereas the remaining 21.9% was explained by variables not included in the regression model. These findings demonstrate that the proposed regression model possesses substantial explanatory power.

The empirical model summarizing the results of the multiple regression analysis, including the direction and magnitude of the relationships among the research variables, is presented in Figure 1.

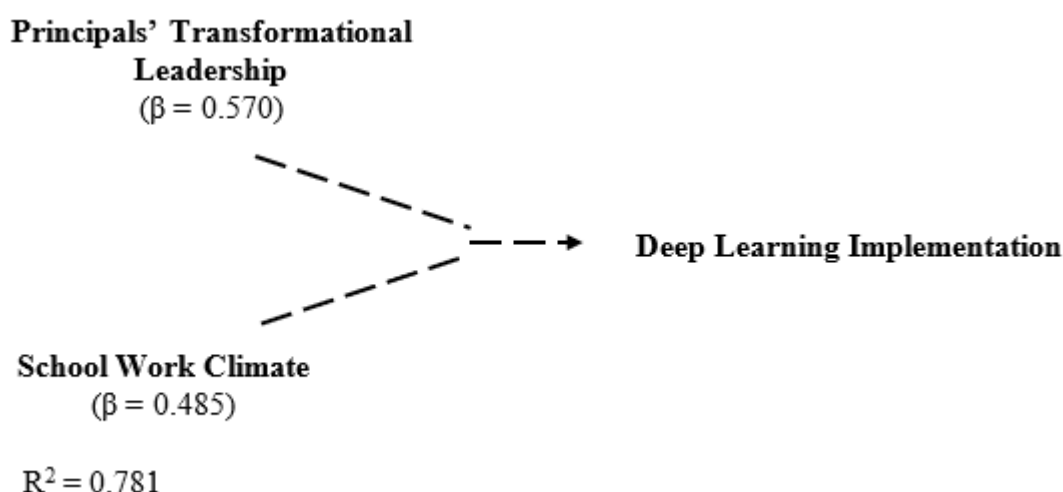


Figure 1. Empirical Model of the Effects of Principals' Transformational Leadership and School Work Climate on Deep Learning Implementation

Figure 1 summarizes the results of the multiple regression analysis, demonstrating that both principals' transformational leadership and school work climate positively influence the implementation of *deep learning*. Based on the standardized beta coefficients, transformational leadership exhibited a stronger contribution than school work climate. In addition, the coefficient of determination confirms that both predictors jointly explain a substantial proportion of the variance in *deep learning* implementation, thereby supporting the robustness of the proposed regression model.

Multiple linear regression analysis was conducted to examine the simultaneous effects of principals' transformational leadership and school work climate on deep learning implementation. This analysis was performed to determine whether the two independent variables collectively contributed to variations in deep learning implementation. The ANOVA test was conducted to evaluate the significance of the regression model. The results are presented in Table 5.

Table 5. Results of ANOVA Test for Multiple Linear Regression Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	155528.531	2	77764.266	208.116	< .001
Residual	43717.969	111	373.658		
Total	199246.500	113			

Dependent Variable: Deep Learning Implementation (Y)

Predictors: (Constant), School Work Climate (X2), Principals' Transformational Leadership (X1)

The ANOVA results indicate that the regression model was statistically significant, with $F(2,111) = 208.116$, $p < .001$. The calculated F-value exceeded the critical F-value (3.080), indicating that principals' transformational leadership and school work climate simultaneously had a significant effect on deep learning implementation. Therefore, hypothesis 3 was supported. To determine the explanatory power of the regression model, the coefficient of determination analysis was conducted. The results are presented in Table 6.

Table 6. Results of Determination Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.884	.781	.777	19.330

Predictors: (Constant), School Work Climate (X2), Principals' Transformational Leadership (X1)

The results show that the multiple correlation coefficient (R) was 0.884, indicating a strong relationship between principals' transformational leadership, school work climate, and deep learning implementation. The coefficient of determination (R^2) was 0.781, indicating that the two independent variables jointly explained 78.1% of the variance in deep learning implementation. The remaining 21.9% was explained by other factors outside the research model.

Based on the interpretation criteria, an R^2 value of 0.781 falls within the strong category (0.60–0.799), indicating that principals' transformational leadership and school work climate provide substantial explanatory power for deep learning implementation. Furthermore, regression coefficients were analyzed to identify the contribution of each predictor variable. Unlike the previous presentation, the β values reported in this analysis represent standardized regression coefficients obtained from the multiple regression output. The complete regression coefficients are presented in Table 7.

Table 7. Coefficients of Multiple Linear Regression Analysis

Predictor	Unstandardized B	Std. Error	Standardized β	t	Sig.
Constant	11.762	10.119	–	1.162	.247
Principals' Transformational Leadership (X1)	.717	.059	.570	12.088	< .001
School Work Climate (X2)	.665	.065	.485	10.280	< .001

Dependent Variable: Deep Learning Implementation (Y)

The regression equation can be expressed as follows: $Y = 11.762 + 0.717X_1 + 0.665X_2$. The regression coefficients indicate that principals' transformational leadership and school work

climate positively influenced deep learning implementation. The standardized regression coefficient of transformational leadership was $\beta = 0.570$ ($p < .001$), indicating that transformational leadership was the strongest predictor of deep learning implementation. Meanwhile, school work climate also demonstrated a significant positive contribution with $\beta = 0.485$ ($p < .001$). These findings confirm that although both organizational factors significantly contribute to deep learning implementation, principals' transformational leadership provides a relatively greater contribution compared with school work climate.

The results demonstrate that principals' transformational leadership has a positive and statistically significant effect on deep learning implementation. The Pearson correlation coefficient ($r = 0.763$) indicates a strong positive relationship, while the simple regression analysis shows that transformational leadership explains 58.2% of the variance in deep learning implementation. These findings imply that instructional transformation is shaped not only by teachers' individual competencies but also by principals' ability to inspire, guide, and empower teachers to adopt meaningful learning practices. Transformational leadership extends beyond administrative management by creating a shared instructional vision and translating that vision into organizational practice. Through idealized influence, principals serve as role models who demonstrate commitment to improving instructional quality. Inspirational motivation encourages teachers to embrace educational change with confidence and optimism, while intellectual stimulation promotes critical reflection on conventional teaching practices and motivates teachers to adopt more student-centered approaches. In addition, individualized consideration enables principals to provide personalized guidance and professional support according to teachers' needs and capacities. The present findings are consistent with previous Indonesian studies demonstrating that transformational leadership enhances teachers' performance by strengthening organizational commitment and encouraging active participation in educational reform (Efendi et al., 2023). Transformational leadership also contributes to higher levels of job satisfaction because teachers feel appreciated, supported, and involved in achieving school goals (Restiani et al., 2024). Furthermore, transformational leadership has been recognized as an effective strategy for integrating organizational change, human resource development, and instructional quality improvement within Indonesian schools (Hardianto et al., 2024).

The study also demonstrates that school work climate has a positive and significant influence on deep learning implementation. The Pearson correlation coefficient ($r = 0.712$) indicates a strong positive relationship, while the simple regression analysis shows that school work climate explains 50.7% of the variance in deep learning implementation. A positive school work climate provides psychological safety, collegial relationships, professional autonomy, and opportunities for collaboration, all of which are essential for implementing innovative instructional approaches. Because deep learning requires teachers to collaboratively design learning activities, exchange professional experiences, evaluate instructional challenges, and continuously refine teaching practices, supportive organizational conditions become indispensable. These findings align with previous studies reporting that school climate contributes significantly to teacher performance, professional motivation, organizational commitment, and job satisfaction (Komariah et al., 2023; Yolviansyah et al., 2024; Rumengan & Idawati, 2024; Wolomasi & Werang, 2022).

The multiple regression analysis demonstrates that principals' transformational leadership and school work climate jointly exert a positive and statistically significant effect on deep learning implementation. The regression model indicates that both variables collectively explain 78.1% of the variance in deep learning implementation. Based on the standardized regression coefficients, transformational leadership ($\beta = 0.570$) contributes more strongly than school

work climate ($\beta = 0.485$). The substantial explanatory power of the regression model suggests that transformational leadership and school work climate function as complementary organizational capacities. Transformational leadership provides strategic direction, inspiration, and professional support for instructional change, whereas school work climate creates the psychological and organizational conditions that enable teachers to implement such changes effectively. These findings reinforce previous studies emphasizing that leadership, school culture, professional learning, and instructional innovation should be viewed as an integrated ecosystem supporting deeper learning (Sliwka et al., 2024; Richardson et al., 2024).

Conclusion

This study concludes that principals' transformational leadership and school work climate are critical organizational factors supporting the implementation of *deep learning* in public elementary schools in Talun District, Pekalongan Regency. The findings demonstrate that principals' transformational leadership has a positive and statistically significant effect on *deep learning* implementation. Specifically, principals' ability to provide exemplary leadership, establish a shared instructional vision, inspire teachers, stimulate intellectual growth, and address teachers' individual professional needs contributes substantially to the transformation of instructional practices toward more meaningful, reflective, collaborative, and higher-order thinking-oriented learning.

The findings also confirm that school work climate has a positive and significant influence on the implementation of *deep learning*. A supportive organizational environment characterized by open communication, harmonious interpersonal relationships, organizational support, psychological safety, clear role expectations, and opportunities for collaboration encourages teachers to adopt innovative instructional practices. Conversely, an unsupportive work climate may discourage teachers from experimenting with new pedagogical approaches and reinforce conventional, teacher-centered instructional practices.

Furthermore, principals' transformational leadership and school work climate jointly exert a substantial influence on *deep learning* implementation, explaining 78.1% of its variance. Although transformational leadership emerged as the stronger predictor, both variables complement one another in creating a school ecosystem that facilitates sustainable instructional transformation. Transformational leadership provides strategic direction and motivation for educational change, whereas a positive school work climate establishes the organizational conditions necessary for implementing that change effectively and consistently.

The findings imply that improving *deep learning* implementation requires a comprehensive school-wide strategy rather than isolated pedagogical training for teachers. Schools should strengthen principals' transformational leadership, establish professional learning communities, promote reflective instructional supervision, encourage teacher collaboration, provide greater professional autonomy, and recognize instructional innovation. Future research is recommended to incorporate additional variables, including teachers' pedagogical competence, collective efficacy, innovative work behavior, technological readiness, and parental support. Employing longitudinal or mixed-method research designs would also provide a more comprehensive understanding of the mechanisms through which organizational factors influence the successful implementation of *deep learning* in elementary education.

Based on these findings, several recommendations can be proposed for educational practice and future research. School principals are encouraged to strengthen transformational

leadership by fostering a shared vision of *deep learning*, supporting collaborative professional learning communities, implementing reflective instructional supervision, and creating a school climate that promotes innovation and continuous improvement. Educational policymakers should prioritize leadership development programs that integrate transformational leadership with instructional leadership to accelerate the implementation of *deep learning* in elementary schools. Future studies are recommended to examine additional organizational and individual factors, such as teachers' digital competence, instructional leadership, organizational learning, collective efficacy, and technology integration. Employing longitudinal, mixed-method, or multilevel research designs across broader educational contexts would also provide a more comprehensive understanding of the mechanisms through which leadership and school organizational conditions influence the sustainable implementation of *deep learning*.

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