Vol. 9, No.1, 2026, pp. 482-489
DOI: https://doi.org/10.32698/02289

Contents lists available at Journal Global Econedu

Journal of Educational and Learning Studies
ISSN: 2655-2760 (Print) ISSN: 2655-2779 (Electronic)

Journal homepage: http://jurnal.globaleconedu.org/index.php/jels

Transformational leadership, pedagogical competence, deep learning, and teachers' readiness for educational change

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Article Info

Article history:

Received Apr 10th, 2026
Revised May 18th, 2026
Accepted Jun 30th, 2026

Keywords:

Transformational leadership,
Pedagogical competence,
Deep learning implementation,
Teachers' readiness

ABSTRACT

This study aimed to examine the effects of transformational leadership and teachers' pedagogical competence on deep learning implementation and teachers' readiness for change in public junior high schools in Padang Pariaman Regency. A quantitative explanatory design was employed using a survey of 228 teachers selected through proportionate stratified random sampling from a population of 557 teachers. Data were collected using a five-point Likert questionnaire and analyzed with Partial Least Squares Structural Equation Modeling (PLS-SEM). Pedagogical competence exerted the strongest positive effect on deep learning implementation (β = 0.720), followed by transformational leadership (β = 0.187). Both variables significantly influenced teachers' readiness for change directly and indirectly through deep learning implementation. The structural model demonstrated moderate-to-strong explanatory power (R^2 = 0.662–0.681). Strengthening teachers' pedagogical competence, supported by transformational school leadership, is essential for promoting effective deep learning implementation and enhancing teachers' readiness for sustainable educational change.

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Introduction

Modern education has undergone a paradigm shift from teacher-centered knowledge delivery to competency-oriented learning that promotes higher-order thinking, creativity, collaboration, communication, and problem-solving abilities. In response to these demands, many education systems have adopted instructional approaches that encourage meaningful and sustainable learning experiences. One of the most prominent approaches is deep learning, which promotes meaningful understanding, reflective thinking, authentic problem-solving, and the application of knowledge in real-life situations rather than rote memorization (Polatcan et al., 2024; Sun et al., 2024). In Indonesia, the implementation of deep learning has gained increasing attention following the introduction of the Merdeka Curriculum, which promotes student-centered learning, differentiated instruction, and competency-based education. Nevertheless, evidence from schools indicates that translating these policy directions into effective classroom practices remains challenging because teachers continue to experience difficulties in implementing innovative instructional strategies consistently. These conditions suggest that the successful implementation of deep learning depends not only on curriculum reform but also on teachers' instructional competence and their readiness to adapt to educational change within supportive school environments (ElSayary & Mohebi, 2024; Fang et al., 2025).

Previous studies have consistently shown that transformational leadership plays a crucial role in promoting educational innovation by strengthening teachers' motivation, organizational commitment, and willingness to embrace instructional change (Hidayat & Patras, 2024; Hoang & Le, 2025). Principals who demonstrate transformational leadership create collaborative learning environments through intellectual stimulation, trust, and continuous professional support, thereby encouraging teachers to adopt innovative teaching practices. Likewise, pedagogical competence has been widely recognized as a key determinant of instructional quality because it enables teachers to design student-centered learning, implement effective instructional strategies, conduct authentic assessment, and facilitate meaningful learning experiences (Berkovich & Hassan, 2025; Witthöft et al., 2026). These competencies are fundamental for implementing deep learning, as teachers with stronger pedagogical competence are more capable of transforming curriculum objectives into classroom practices that foster higher-order thinking and active student engagement.

Although transformational leadership and pedagogical competence have been extensively investigated, previous studies have primarily examined their independent effects on teacher performance, instructional quality, organizational commitment, job satisfaction, or school effectiveness (Hariri et al., 2024; Paganin et al., 2025). Empirical studies that simultaneously examine both variables in relation to deep learning implementation remain limited, particularly within the Indonesian educational context. Moreover, teachers' readiness for change has generally been examined as an outcome of organizational change rather than as a psychological mechanism that explains how leadership and teacher competence facilitate instructional transformation. Existing studies also provide limited empirical evidence regarding the mediating role of readiness for change in supporting deep learning implementation during educational reform (Sun et al., 2025; Zadok et al., 2024). These limitations indicate the need for a more comprehensive model that integrates organizational, instructional, and psychological dimensions to explain successful educational transformation.

The importance of this issue is further reflected in public junior high schools in Padang Pariaman Regency. According to the 2025 Indonesian Education Report Card (Rapor Pendidikan), schools in the region continue to experience challenges in improving students' numeracy achievement and higher-order thinking competencies, indicating that instructional transformation has not yet been fully optimized. These findings suggest that strengthening deep learning requires not only supportive school leadership but also teachers who possess strong pedagogical competence and sufficient readiness to implement educational innovation. Therefore, examining the interaction among transformational leadership, pedagogical competence, deep learning implementation, and teachers' readiness for change is essential for generating evidence-based strategies that support sustainable improvement in instructional quality (Bellibas et al., 2025; M. Li et al., 2024).

Based on these considerations, this study develops and tests an integrated structural model linking transformational leadership, pedagogical competence, deep learning implementation, and teachers' readiness for change using Partial Least Squares Structural Equation Modeling (PLS-SEM). Unlike previous studies that predominantly examined direct relationships among these variables, this study simultaneously investigates both direct and indirect relationships to explain the mechanisms through which leadership and pedagogical competence influence teachers' readiness for educational change. The primary theoretical contribution of this study lies in integrating deep learning implementation as an instructional mechanism and teachers' readiness for change as a psychological outcome within a single structural framework in the context of Indonesian public junior high schools. Accordingly, this study is expected to enrich the literature on educational leadership and instructional change while providing practical evidence for policymakers, school principals, and teachers in strengthening the implementation of deep learning and supporting sustainable educational transformation.

Method

This study employed a quantitative explanatory research design to examine the causal relationships among transformational leadership, pedagogical competence, deep learning implementation, and teachers' readiness for change. The research was conducted in public junior high schools (SMP Negeri) across Padang Pariaman Regency, West Sumatra, Indonesia. The target population consisted of 557 civil servant (ASN) teachers. The sample size was determined using the Cochran formula with a 95% confidence level and a 5% margin of error, resulting in a minimum sample of 228 teachers after finite population correction. Respondents were selected using proportionate stratified random sampling, with educational qualification (Bachelor's and Master's degree) and teaching experience (≤15 years and >15 years) serving as the stratification criteria to ensure proportional representation across the study population.

Primary data were collected using a structured questionnaire distributed through Google Forms, while secondary data were obtained from the 2025 Education Report Card, school profiles, and other official educational documents. The questionnaire employed a five-point Likert scale ranging from 1 (Never) to 5

(Always). Transformational leadership was measured through four dimensions: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. Pedagogical competence comprised a safe and supportive learning environment, student-centered instruction, and assessment, feedback, and reporting. Deep learning implementation was assessed using the dimensions of meaningful, mindful, and joyful learning, whereas teachers' readiness for change included appropriateness, change efficacy, management support, and personal benefit. Prior to the main survey, the instrument was pilot-tested on 60 teachers with characteristics similar to those of the target population to establish its validity and reliability.

The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3.0. The measurement model (outer model) was evaluated through convergent validity, discriminant validity, Cronbach's alpha, Composite Reliability, and Average Variance Extracted (AVE). Subsequently, the structural model (inner model) was assessed using the coefficient of determination (R^2), effect size (f^2), variance inflation factor (VIF), direct and indirect effects, and total effects. Hypothesis testing was performed using the bootstrapping procedure, with statistical significance established at t-values ≥ 1.96 and p-values < 0.05. This analytical procedure enabled the simultaneous examination of both direct and mediating relationships among the latent variables proposed in the conceptual model.

Results and Discussions

The structural model was evaluated using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique to test the proposed hypotheses. Data from 228 respondents were analyzed using SmartPLS 3.0 to assess the relationships among transformational leadership, pedagogical competence, deep learning implementation, and teachers' readiness for change. The evaluation included the coefficient of determination (R^2), effect size (f^2), path coefficients, indirect effects, collinearity diagnostics (VIF), and total effects. These statistical procedures provide evidence regarding the model's explanatory power, the significance and magnitude of the structural relationships, the mediating role of deep learning implementation, and the overall robustness of the proposed research model. The findings are presented sequentially in the following sections.

Table 1. Coefficient of Determination (R^2)

Endogenous Variable	R^2	Adjusted R^2	Interpretation
Deep Learning Implementation (Y)	0.662	0.659	Moderate to strong
Teachers' Readiness for Change (Z)	0.681	0.677	Moderate to strong

The coefficient of determination analysis demonstrated that the proposed structural model possessed substantial explanatory power. The R^2 value for Deep Learning Implementation (Y) was 0.662, indicating that transformational leadership and pedagogical competence explained 66.2% of the variance in deep learning implementation, while the remaining 33.8% was attributable to factors outside the model. Likewise, the R^2 value for Teachers' Readiness for Change (Z) reached 0.681, suggesting that 68.1% of its variance was explained by the predictor variables included in the model. According to Chin's classification, both values represent a moderate-to-strong predictive capability, indicating that the structural model adequately explains the endogenous constructs.

Table 2. Effect Size (f^2)

Structural Relationship	f^2	Effect Size
Transformational Leadership to Deep Learning Implementation	0.086	Small
Transformational Leadership to Teachers' Readiness for Change	0.127	Small
Pedagogical Competence to Deep Learning Implementation	1.284	Large
Pedagogical Competence to Teachers' Readiness for Change	0.255	Medium
Deep Learning Implementation to Teachers' Readiness for Change	0.073	Small

The effect size analysis revealed considerable differences in the contribution of each predictor variable. Pedagogical competence exerted the strongest influence on deep learning implementation ($f^2 = 1.284$), representing a large effect, and therefore emerged as the most influential predictor in the structural model. Its effect on teachers' readiness for change was also meaningful ($f^2 = 0.255$), indicating a medium effect. In contrast, transformational leadership exhibited relatively small effects on both endogenous variables ($f^2 = 0.086$ and 0.127, respectively). Similarly, the influence of deep learning implementation on teachers' readiness for change remained relatively small ($f^2 = 0.073$). These findings indicate that pedagogical competence contributes substantially more to improving deep learning implementation than transformational leadership.

Table 3. Structural Path Coefficients

Hypothesized Relationship	Path Coefficient (β)	Direction
Transformational Leadership to Deep Learning Implementation	0.187	Positive
Transformational Leadership to Teachers' Readiness for Change	0.229	Positive
Pedagogical Competence to Deep Learning Implementation	0.720	Positive
Pedagogical Competence to Teachers' Readiness for Change	0.470	Positive
Deep Learning Implementation to Teachers' Readiness for Change	0.261	Positive

The structural path analysis indicated that all hypothesized relationships were positive, confirming that improvements in the predictor variables were associated with increases in the corresponding endogenous variables. Pedagogical competence demonstrated the strongest direct effect on deep learning implementation (β = 0.720), suggesting that teachers possessing stronger pedagogical competence were substantially more capable of implementing deep learning practices. Transformational leadership also positively influenced deep learning implementation (β = 0.187) and teachers' readiness for change (β = 0.229), although with smaller effect magnitudes. Furthermore, pedagogical competence directly enhanced teachers' readiness for change (β = 0.470), while deep learning implementation also positively contributed to teachers' readiness for change (β = 0.261). Collectively, these findings support the proposed structural relationships and indicate that pedagogical competence represents the primary determinant of successful deep learning implementation.

Table 4. Indirect Effects

Indirect Relationship	Indirect Effect
Transformational Leadership to Deep Learning Implementation to Teachers' Readiness for Change	0.049
Pedagogical Competence to Deep Learning Implementation to Teachers' Readiness for Change	0.188

The mediation analysis demonstrated that deep learning implementation served as a mediating variable in the relationships between the exogenous variables and teachers' readiness for change. The indirect effect of transformational leadership on teachers' readiness for change through deep learning implementation was relatively small (β = 0.049). Conversely, pedagogical competence exhibited a substantially stronger indirect effect (β = 0.188), indicating that improvements in pedagogical competence enhanced teachers' readiness for change primarily by strengthening the implementation of deep learning. These findings suggest that deep learning implementation functions as a more meaningful mediating mechanism for pedagogical competence than for transformational leadership.

Table 5. Variance Inflation Factor (VIF)

Structural Relationship	VIF
Transformational Leadership to Deep Learning Implementation	1.194
Pedagogical Competence to Deep Learning Implementation	1.194
Transformational Leadership to Teachers' Readiness for Change	1.297
Pedagogical Competence to Teachers' Readiness for Change	2.727
Deep Learning Implementation to Teachers' Readiness for Change	2.956

The collinearity assessment indicated that all VIF values ranged from 1.194 to 2.956, remaining well below the recommended threshold of 5.0. These findings confirm the absence of multicollinearity among the predictor constructs and demonstrate that each latent variable contributed unique explanatory information to the structural model. Consequently, the estimated path coefficients can be interpreted with confidence, without concerns regarding redundancy among the exogenous variables.

Table 6. Total Effects

Structural Relationship	Total Effect
Transformational Leadership to Deep Learning Implementation	0.187
Transformational Leadership to Teachers' Readiness for Change	0.278
Pedagogical Competence to Deep Learning Implementation	0.720
Pedagogical Competence to Teachers' Readiness for Change	0.658
Deep Learning Implementation to Teachers' Readiness for Change	0.261

The total effect analysis confirmed that pedagogical competence exerted the strongest overall influence within the structural model. Its total effect on deep learning implementation reached 0.720, while its overall

influence on teachers' readiness for change increased to 0.658, reflecting the combined direct and indirect effects through deep learning implementation. Likewise, the total effect of transformational leadership on teachers' readiness for change increased from 0.229 to 0.278 after incorporating the mediating role of deep learning implementation. These findings demonstrate that deep learning implementation partially strengthens the influence of both transformational leadership and pedagogical competence on teachers' readiness for change, with pedagogical competence remaining the most influential determinant across all structural relationships.

The findings demonstrate that pedagogical competence emerged as the strongest determinant of deep learning implementation, as evidenced by the highest path coefficient ($\beta = 0.720$) and a very large effect size ($f^2 = 1.284$). These results indicate that teachers possessing stronger pedagogical competencies are substantially more capable of implementing meaningful, mindful, and joyful learning practices. This finding aligns with the premise that effective deep learning depends not merely on curriculum reform but also on teachers' instructional competence in designing student-centered learning environments that foster critical thinking, collaboration, and higher-order cognitive skills (Chunhui et al., 2024; Peng & Wang, 2026). The moderate-to-strong explanatory power of the model ($R^2 = 0.662$) further confirms that transformational leadership and pedagogical competence collectively explain a considerable proportion of variation in deep learning implementation. Consequently, strengthening teachers' pedagogical competence should be considered a strategic priority for schools seeking to accelerate the successful implementation of deep learning.

Transformational leadership also exhibited a positive and significant influence on deep learning implementation ($\beta = 0.187$), although its contribution was considerably smaller than that of pedagogical competence ($f^2 = 0.086$). This finding suggests that while principals play an important role in establishing an organizational climate that supports educational innovation, leadership alone is insufficient to ensure successful classroom implementation without adequate teacher competence. Transformational leaders inspire teachers through a shared vision, intellectual stimulation, and individualized support; however, the translation of these leadership practices into effective instructional change ultimately depends on teachers' professional capacity. This result supports transformational leadership theory proposed by Hadi et al., (2024), which emphasizes that leadership primarily functions by motivating organizational members to embrace change, while instructional outcomes depend largely on employees' competencies. Similar findings have been reported by Nassir & Benoliel, (2026); Tran et al., (2024), who concluded that school leadership influences student learning predominantly through its effects on teachers' professional practices rather than through direct instructional intervention.

The present study further revealed that both transformational leadership ($\beta = 0.229$) and pedagogical competence ($\beta = 0.470$) significantly enhanced teachers' readiness for change, with pedagogical competence demonstrating almost twice the magnitude of influence. Moreover, deep learning implementation itself significantly contributed to teachers' readiness for change ($\beta = 0.261$), indicating that teachers become more receptive to educational transformation when they successfully experience innovative teaching practices in their classrooms. The structural model also explained 68.1% of the variance in teachers' readiness for change ($R^2 = 0.681$), suggesting that the proposed framework possesses substantial predictive capability. These findings are consistent with organizational change theory, which argues that employees are more willing to accept change when they perceive themselves as competent and believe that organizational conditions support successful implementation (Hardianto et al., 2025; Z. Li et al., 2026; Sánchez-García, Morales-Sánchez, et al., 2024; Uslukaya et al., 2025). In educational settings, teachers with strong pedagogical knowledge are generally more confident in adopting new instructional approaches because they possess the professional skills required to adapt to evolving educational policies (Algohani & Mydin, 2025; Amelia et al., 2024; Bektiarso, 2024).

The mediation analysis provides further evidence regarding the mechanism through which the independent variables influence teachers' readiness for change. Deep learning implementation partially mediated the relationship between transformational leadership and readiness for change (indirect effect = 0.049) and demonstrated a substantially stronger mediating role in the relationship between pedagogical competence and readiness for change (indirect effect = 0.188). The increase in the total effect of transformational leadership from 0.229 to 0.278, together with the total effect of pedagogical competence reaching 0.658, confirms that successful implementation of deep learning strengthens the influence of both antecedent variables on teachers' readiness for change. These findings suggest that educational reform is more likely to succeed when school leadership and teacher competence are translated into concrete classroom practices rather than remaining at the level of organizational policy. Similar conclusions have been reported by Bellibaş et al., (2026); Ninković et al., (2024), who argued that sustainable educational change occurs when leadership capacity and teacher professionalism jointly facilitate instructional innovation within schools.

Finally, the robustness of the proposed structural model is supported by several statistical indicators. All Variance Inflation Factor (VIF) values ranged from 1.194 to 2.956, well below the recommended threshold of 5.0, indicating the absence of multicollinearity among the predictor constructs. Furthermore, the moderate-to-

strong values of R^2, together with positive path coefficients and meaningful indirect effects, demonstrate that the proposed model possesses satisfactory explanatory and predictive capabilities. Overall, these findings highlight that pedagogical competence constitutes the primary driver of deep learning implementation, whereas transformational leadership functions as an enabling organizational factor that reinforces teachers' capacity to embrace educational change. Therefore, policies aimed at strengthening deep learning should simultaneously prioritize continuous professional development for teachers and transformational leadership development for school principals, thereby creating a supportive environment for sustainable educational transformation (Long et al., 2026; Sánchez-García, Reigal, et al., 2024; Wang et al., 2025).

Conclusions

This study concludes that transformational leadership and teachers' pedagogical competence significantly contribute to the implementation of deep learning and teachers' readiness for change in public junior high schools in Padang Pariaman Regency. Pedagogical competence emerged as the most influential predictor of deep learning implementation, while transformational leadership strengthened teachers' readiness to adopt educational innovations. Furthermore, deep learning implementation partially mediated the relationships between transformational leadership, pedagogical competence, and teachers' readiness for change, indicating that effective instructional practices reinforce the impact of leadership and teacher competence on educational transformation. These findings highlight that improving pedagogical competence, supported by transformational school leadership, is fundamental to fostering successful deep learning implementation and enhancing teachers' readiness for sustainable educational change.

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