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The Effect of Transformational Leadership on Teachers' and Students' Digital Adoption of Artificial Intelligence Technology in Elementary Schools Across Jatisampurna District Bekasi City

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Abstract

Artificial intelligence (AI) is increasingly used in elementary education, yet its adoption may differ between teachers and students and may depend on school leadership. This study examined the effect of principals' transformational leadership on teachers' and students' adoption of AI technology, with teachers' adoption tested as a mediating variable. A quantitative causal-associative design was used. Participants were 37 fourth- and fifth-grade teachers and 235 students from seven elementary schools in Jatisampurna District, Bekasi City, Indonesia. Data were collected through four-point Likert-scale questionnaires and analyzed using descriptive statistics and Hayes PROCESS Model 4 with 5,000 bootstrap samples. Student scores were aggregated by teacher for the mediation analysis ($n = 37$). Transformational leadership, teachers' AI adoption, and students' AI adoption were all rated positively. Transformational leadership significantly predicted teachers' AI adoption ($b = 0.9462$, $p < .001$), explaining 76.85% of its variance. However, transformational leadership did not significantly predict students' adoption, teachers' adoption did not significantly predict students' adoption, and the indirect effect was not significant. The findings indicate that leadership can strengthen teachers' AI use, but student adoption requires more direct pedagogical involvement, guidance, access, and support.

Keywords: transformational leadership; teachers' AI adoption; students' AI adoption

1. Introduction

Artificial intelligence has become increasingly relevant to elementary education. Teachers can use AI to prepare instructional materials, design learning activities, develop assessments, and access information more efficiently. Students can use it to review lessons, explore new concepts, and obtain assistance with learning tasks. Nevertheless, the availability of AI does not ensure that teachers and students will adopt it meaningfully. Adoption depends on whether users perceive an innovation as advantageous, compatible with their needs, sufficiently easy to use, open to experimentation, and capable of producing observable benefits (Rogers, 1983). In educational settings, the process also requires ethical awareness, digital competence, suitable policies, and collaboration among school stakeholders (Sugiono, 2024).

Teachers occupy a central position in school technology adoption because they determine how technology is incorporated into teaching. Their acceptance of AI is influenced by more than access to hardware or applications. Granström and Oppi (2025) found that teachers' readiness, perceived usefulness, confidence, and access to institutional support were important predictors of AI use. Similarly, Darmawan et al. (2024) identified technological

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optimism, innovativeness, trust, perceived usefulness, and ease of use as important factors in AI adoption among elementary school teachers. These findings suggest that schools must develop both teachers' technical competence and their confidence in the educational value of AI.

Students' adoption of AI may follow a different process. The Unified Theory of Acceptance and Use of Technology explains technology adoption through performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). Students are more likely to use AI when they believe that it improves their learning, is easy to operate, is supported by people around them, and can be accessed through adequate devices and internet connections. Mistry et al. (2025) reported that habit, facilitating conditions, and social influence contributed to students' intentions and behavior in using AI tools. Polyportis and Pachos-Fokialis (2024) also found that students' attitudes and behavioral intentions were associated with performance expectancy, social influence, facilitating conditions, trust, and perceived ease of use. Although these studies involved older students, their findings show that student adoption is closely connected to direct user experience and the surrounding social and technological environment.

School leadership may establish the organizational conditions needed for AI adoption. Transformational leadership consists of idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration (Bass & Avolio, 1994). Principals who apply these dimensions can communicate a digital vision, motivate teachers to experiment, support professional development, and provide resources for technology-supported instruction. Schmitz et al. (2023) found that transformational leadership supported teachers' use of technology and their ability to design more demanding technology-supported learning activities. Zeng et al. (2025) similarly emphasized the role of school leaders in developing teachers' competence to integrate AI.

The influence of principal leadership may be stronger for teachers than for students. Teachers interact directly with principals and experience school policies, professional development, supervision, and resource allocation. Students generally experience principal leadership indirectly through their teachers, learning activities, school facilities, and the digital culture of the school. Berkovich and Hassan (2024) found that digital instructional leadership influenced student learning through teachers' intrinsic motivation. This indicates that teachers may act as an intermediary between school leadership and student outcomes.

However, greater teacher adoption does not automatically produce greater student adoption. Teachers may use AI for lesson preparation, presentations, assessment, or administrative work without involving students directly. Abedi (2024) found that teachers frequently used technology for preparation and direct instructional delivery, while student-centered applications were more limited. Therefore, examining only the level of teacher AI use may not show whether students receive opportunities to observe, try, and benefit from the technology.

Research on the relationship among transformational leadership, teachers' AI adoption, and students' AI adoption remains limited at the Indonesian elementary-school level. This study addresses that gap by examining elementary schools in Jatisampurna District, Bekasi City. It describes the levels of transformational leadership and AI adoption and tests four hypotheses: transformational leadership affects students' AI adoption (H1), transformational

leadership affects teachers' AI adoption (H2), teachers' AI adoption affects students' AI adoption (H3), and teachers' AI adoption mediates the relationship between transformational leadership and students' AI adoption (H4).

2. Method

2.1. Research design and setting

This study used a quantitative approach with a causal-associative survey design. Transformational leadership was specified as the independent variable (X), teachers' digital adoption of AI technology as the mediating variable (M), and students' digital adoption of AI technology as the dependent variable (Y). The study was conducted in 2026 at seven elementary schools in Jatisampurna District, Bekasi City, Indonesia. The participating schools were selected because they had incorporated AI technology into teaching and learning.

2.2. Population and sample

The research population comprised fourth- and fifth-grade teachers and students from the seven participating schools. Purposive sampling was used to select schools and respondents who met the research criteria. All 37 eligible fourth- and fifth-grade teachers were included in the teacher sample. The student population consisted of 572 fourth- and fifth-grade students. The required sample was calculated using the Slovin formula with a 5% margin of error, resulting in a sample of 235 students. Thus, the original data consisted of responses from 37 teachers and 235 students.

2.3. Research instruments and data collection

Data were collected using closed-ended questionnaires with a four-point Likert scale: strongly agree (4), agree (3), disagree (2), and strongly disagree (1). A four-point scale was used to obtain a clear response direction without a neutral category. The transformational-leadership instrument measured idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. Teachers' AI adoption was measured through relative advantage, compatibility, complexity, trialability, and observability, based on the diffusion-of-innovations framework (Rogers, 1983). Students' AI adoption was measured through performance expectancy, effort expectancy, social influence, and facilitating conditions, based on UTAUT (Venkatesh et al., 2003).

Two educational-management experts reviewed the content, wording, consistency, and suitability of the questionnaire items. Empirical validity testing was subsequently conducted using corrected item-total correlations. The three instruments demonstrated high internal consistency, with Cronbach's alpha values of .977 for transformational leadership, .954 for teachers' AI adoption, and .978 for students' AI adoption. The questionnaires were distributed online through Google Forms, and the links were shared through WhatsApp. Respondents' identifying information was kept confidential.

2.4. Data analysis

Descriptive statistics were used to calculate the minimum, maximum, mean, and standard deviation for each variable. Scores were also classified into strongly disagree,

disagree, agree, and strongly agree categories. Because transformational leadership and teachers' AI adoption were measured at the teacher level (n = 37), whereas student adoption was initially measured at the individual student level (n = 235), student scores were aggregated by teacher before mediation analysis. The mean adoption score of the students taught by each teacher was calculated, producing a consistent teacher-level analytical sample of 37 cases.

Hypotheses were tested in IBM SPSS 26 using Hayes PROCESS version 4.2, Model 4. The analysis estimated the total effect of transformational leadership on students' adoption, the effect of transformational leadership on teachers' adoption, the effect of teachers' adoption on students' adoption after controlling for transformational leadership, and the indirect effect through teachers' adoption. The mediation test used 5,000 bootstrap samples and a 95% confidence interval. An effect was considered statistically significant when $p < .05$. An indirect effect was considered significant when its bootstrap confidence interval did not include zero..

3. Results and Discussion

3.1. Result

The study involved 37 teachers and 235 students from seven elementary schools. For the mediation analysis, student responses were aggregated according to the teacher who taught them, resulting in 37 teacher-level observations for each variable.

Table 1. Descriptive statistics of the research variables

	N	Minimum	Maximum	Mean	Std. Deviation	Agree or strongly agree
Transformational Leadership	37	18	72	59.89	11.518	94.6%
Teachers' Digital Adoption	37	22	80	64.19	12.432	94.6%
Students' Digital Adoption	37	37	73	54.38	7.562	78.4%

Transformational leadership had a mean score of 59.89. Nineteen respondents, or 51.4%, were in the agree category, while 16 respondents, or 43.2%, were in the strongly agree category. Thus, 94.6% of respondents provided positive assessments of principals' transformational leadership.

Teachers' AI adoption had a mean score of 64.19. Twenty-one respondents, or 56.8%, were in the agree category, and 14 respondents, or 37.8%, were in the strongly agree category. These results show that teachers had generally accepted and used AI to support their professional and instructional responsibilities.

Students' AI adoption had a mean score of 54.38. Twenty-five teacher-level student groups, or 67.6%, were in the agree category, while four groups, or 10.8%, were in the strongly agree category. Eight groups, or 21.6%, were classified in the disagree category. Student adoption was therefore positive overall, although it was less uniform than teachers' adoption.

Table 2. Hypothesis-testing and mediation results

Hypothesis	Relationship	Estimate	SE/BootSE	t	p	95% CI/Bootstrap CI	Decision
H1	X → Y, total effect	−0.0730	0.1103	−0.6616	.5125	[−0.2969, 0.1509]	Not supported
H2	X → M	0.9462	0.0878	10.7794	< .001	[0.7680, 1.1244]	Supported
H3	M → Y, controlling for X	−0.1102	0.2147	−0.5133	.6111	[−0.5464, 0.3260]	Not supported
H4	X → M → Y	−0.1043	0.1617	—	—	[−0.3523, 0.2636]	Not supported

The total effect of transformational leadership on students' AI adoption was negative and statistically insignificant (b = −0.0730, p = .5125). The confidence interval included zero, and transformational leadership explained only 1.24% of the variance in students' adoption. H1 was therefore not supported.

Transformational leadership had a positive and significant effect on teachers' AI adoption (b = 0.9462, p < .001). A one-unit increase in transformational leadership was associated with an estimated increase of 0.9462 units in teachers' adoption scores. Transformational leadership explained 76.85% of the variance in teachers' AI adoption. H2 was therefore supported.

After transformational leadership was controlled, teachers' AI adoption did not significantly predict students' AI adoption (b = −0.1102, p = .6111). The coefficient was negative and its confidence interval included zero. Consequently, H3 was not supported.

The indirect effect of transformational leadership on students' adoption through teachers' adoption was −0.1043. Its bootstrap confidence interval ranged from −0.3523 to 0.2636 and included zero. H4 was therefore not supported, indicating that neither full nor partial mediation occurred.

3.2. Discussion

3.2.1 Transformational leadership and teachers' AI adoption

The descriptive findings show that principals' transformational leadership was perceived positively. Principals were considered capable of providing direction, motivating teachers, encouraging innovative thinking, and responding to teachers' individual needs. These practices correspond with the four dimensions described by Bass and Avolio (1994).

More importantly, transformational leadership had a positive and significant effect on teachers' AI adoption. This was the only supported hypothesis. The result indicates that teachers were more likely to accept and use AI when principals communicated a clear direction, supported experimentation, provided motivation, and created opportunities for professional learning.

This finding is consistent with Schmitz et al. (2023), who found that transformational leadership supported teachers' use of digital technology and their development of more demanding technology-supported learning activities. Zeng et al. (2025) also identified school leadership, professional development, and institutional support as important conditions for teachers' competence in integrating AI.

Teachers' personal readiness remains important. Granström and Oppi (2025) found that readiness and perceived usefulness were among the strongest predictors of teachers' AI adoption. Darmawan et al. (2024) similarly found that teacher adoption was related to optimism, innovativeness, trust, usefulness, and ease of use. Transformational principals can influence these factors by providing training, access to resources, collegial support, and a safe environment for teachers to experiment with AI.

3.2.2 Transformational leadership and students' AI adoption

Transformational leadership did not significantly affect students' AI adoption. Although principals were rated positively, their leadership did not directly determine whether students used AI. This result can be explained by the greater organizational distance between principals and students. Teachers interact directly with principals, whereas students experience leadership through classroom instruction, school facilities, rules, and learning opportunities.

Berkovich and Hassan (2024) found that principals' digital instructional leadership affected student learning through teachers' intrinsic motivation. This suggests that leadership may influence student outcomes through several stages rather than through an immediate relationship. In the present study, however, the proposed pathway through teachers' AI adoption was not statistically supported.

Students' technology behavior may be influenced more strongly by factors that they experience directly. UTAUT identifies performance expectancy, effort expectancy, social influence, and facilitating conditions as major determinants of technology adoption (Venkatesh et al., 2003). Mistry et al. (2025) found that students' use of AI was related to habit, facilitating conditions, and social influence. Polyportis and Pachos-Fokialis (2024) also reported that student use was shaped by behavioral intention, perceived performance, social influence, facilitating conditions, trust, and ease of use.

Therefore, positive principal leadership alone may be insufficient to increase student adoption. Students also need direct access to suitable AI tools, clear explanations of their benefits, opportunities to use them during lessons, support from teachers and parents, and guidance on safe and responsible use.

3.2.3 Teachers' AI adoption and the absence of mediation

Teachers' AI adoption did not significantly affect students' adoption. Teachers could have used AI frequently without involving students in that use. For example, teachers may have used AI to locate references, prepare teaching materials, develop presentation slides, construct questions, or support assessment. These activities represent teacher adoption but do not necessarily provide students with direct AI experience.

Abedi (2024) found that teachers often used technology for lesson preparation and direct instruction rather than student-centered learning. This distinction may explain why

teachers' AI adoption was high but did not predict students' adoption. Technology used as a teacher productivity tool cannot be assumed to change student behavior.

Kastorff and Stegmann (2024) also found that teachers' technological and technological-pedagogical knowledge did not automatically predict students' ICT literacy. The effect of teacher competence depends on how that competence is translated into classroom practice. Students need active opportunities to observe, explore, evaluate, and use technology, rather than merely receiving materials that teachers have prepared with it.

The mediation hypothesis was not supported because only the first part of the mediation pathway was significant. Transformational leadership affected teachers' adoption, but teachers' adoption did not subsequently affect students' adoption. The indirect effect consequently remained insignificant.

This result does not mean that teachers have no role in student AI adoption. It indicates that teacher use must be pedagogically connected to student learning. Eusebio et al. (2025) identified inadequate training, infrastructure limitations, ethical concerns, anxiety, and weak alignment with pedagogy as barriers to educator acceptance and integration of AI. Tripathi et al. (2025) similarly emphasized the need for teacher development that includes pedagogy, critical evaluation, responsible use, data security, and strategies for student engagement.

Teachers should therefore move beyond personal and administrative uses of AI. They need to design guided learning activities in which students can use AI to explore information, solve problems, develop ideas, and evaluate generated content. Such activities should also teach students to verify information, protect personal data, respect academic integrity, and understand the limitations of AI.

3.2.4 Research implications and limitations

The findings distinguish between positive perceptions and statistically supported relationships. Transformational leadership, teacher adoption, and student adoption were all rated positively, but positive descriptive scores did not demonstrate that the variables influenced one another. Only the relationship between transformational leadership and teachers' AI adoption was statistically supported.

Several limitations should be considered. The mediation analysis contained only 37 teacher-level observations and involved seven schools in one district. The use of purposive sampling limits the generalizability of the results. Data were also obtained through self-reported questionnaires, which may not fully represent actual classroom practice. Furthermore, aggregating student scores at the teacher level reduced student-level variation.

Future research should involve more schools and respondents from different regions. Variables such as perceived usefulness, ease of use, digital literacy, peer influence, parental support, device availability, internet access, and facilitating conditions should be examined. Multilevel analysis could also distinguish teacher-, student-, and school-level effects more appropriately. Interviews or classroom observations may help explain why high teacher AI adoption does not necessarily translate into student adoption.

4. Conclusion

Transformational leadership, teachers' AI adoption, and students' AI adoption were rated positively in the participating elementary schools. However, only one of the four proposed hypotheses was supported. Transformational leadership had a positive and significant effect on teachers' AI adoption and explained 76.85% of its variance. It did not significantly affect students' AI adoption, teachers' adoption did not significantly affect students' adoption, and teachers' adoption did not mediate the relationship between transformational leadership and student adoption.

The findings show that principal leadership is effective in encouraging teachers to accept and use AI. Nevertheless, strengthening teacher adoption alone is not sufficient to increase student adoption. Principals should combine leadership support with policies that require meaningful pedagogical integration of AI. Teachers should provide guided opportunities for students to use AI in learning rather than limiting its use to lesson preparation and administrative work. Schools should also provide adequate facilities, parental involvement, and clear standards for ethical, safe, and responsible AI use.

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