

The Influence of Digital Culture, Teacher AI Competence, and Teacher Leadership on Student AI Leadership and Academic Performance at Senior High School in Muaro Jambi

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ABSTRACT

This study examines the impact of digital culture, teachers' AI competence, and teacher leadership on students' AI leadership and academic performance amid digital transformation in education. Grounded in an extended Technology Acceptance Model (TAM), the research explores how these constructs interact to influence AI integration in teaching and learning. A quantitative approach was employed, with data collected from students at Senior High School in Muaro Jambi who engaged in AI-assisted learning. Using Partial Least Squares Structural Equation Modeling (PLS-SEM) for analysis, the study found that digital culture significantly and positively impacts teacher leadership, teacher AI competence, and student AI leadership, positioning digital culture as a primary enabler of technological and pedagogical innovation. However, the direct effects of teacher leadership, teacher AI competence, and student AI leadership on academic performance were positive but statistically insignificant, suggesting that their influence is mediated through pathways of leadership and competence development. These findings underscore the importance of fostering a strong digital culture for AI adoption and highlight that improvements in academic performance require sustained pedagogical alignment and implementation. This research contributes to the theoretical expansion of TAM by integrating cultural and human dimensions. It offers practical insights for educators and policymakers aiming to strengthen AI integration for educational transformation.



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INTRODUCTION

The rapid advancement of artificial intelligence (AI) technologies is reshaping the educational landscape worldwide. Schools are now required to adapt their pedagogical practices, leadership structures, and digital cultures to prepare students for AI-driven societies. Digital culture is a fundamental element underpinning educational transformation in the current era of technological advancement. This concept encompasses a set of values, behaviors, and interaction patterns that arise from the use of digital technology in learning

and school management. According to Wulan Ayu & Fitriyanto (2022), the development of digital culture is primarily influenced by the community's level of knowledge and technological literacy. A strong digital culture not only facilitates the adoption of technology but also fosters an innovative, collaborative, and adaptive mindset within the educational environment.

A high level of digital literacy strengthens schools' ability to adapt to technological change and develop innovation-based practices. Rasdiana *et al.* (2024) emphasized that a robust digital culture plays a critical role in building a learning ecosystem that is responsive to change and promotes collaboration between teachers and students. Furthermore, digital culture serves as a moral and ethical foundation for the responsible use of technology in academic contexts. Schools that have successfully cultivated a strong digital culture tend to create learning environments oriented not only toward technical proficiency but also toward ethical responsibility. In line with this, Wulan Ayu & Fitriyanto (2022) asserted that digital culture is a prerequisite for digital transformation, as it primarily involves changing mindsets to adapt to digital developments. Therefore, strengthening digital culture is a strategic step for schools to address the challenges of technology-driven educational transformation. In the educational context, digital culture serves as the foundation for institutional adaptation to technological advancement. It embodies shared values, norms, and behaviors that encourage collaboration, innovation, and openness to digital transformation. Schools that successfully nurture a strong digital culture tend to demonstrate greater readiness to integrate artificial intelligence (AI) tools into teaching and administration (Rasdiana *et al.*, 2024). Thus, fostering digital culture within schools is essential to prepare both teachers and students for the demands of AI-driven education.

Another key component of digital transformation is teacher AI competence, the teachers' ability to understand, use, and apply AI technologies effectively in educational settings. According to Filiz *et al.* (2025), the findings reveal that teachers valued AI for its efficiency, interactivity, and adaptability, particularly in tools like *ChatGPT* and *MagicSchool*, which supported personalized learning and lesson planning. With artificial intelligence, students' performance data are analyzed and adapted to their individual needs (Mohamed *et al.*, 2025). Therefore, enhancing teachers' AI competence is a crucial step toward developing effective AI leadership in schools.

Technology is used in learning through a variety of innovative approaches aimed at improving educational practices (Chastanti *et al.*, 2024). According to Rasdiana *et al.* (2024) this culture is crucial for ensuring the effectiveness of the collaborative learning process that meets the needs of students in this digital-savvy era. Equally important is teacher leadership, which plays a key role in guiding this transformation and fostering continuous innovation in the learning environment. Teacher leadership enhances digital competence and promotes innovation within schools (Ghamrawi *et al.* 2024).

Artificial Intelligence (AI) has emerged as a transformative force in education, enabling data-driven decisions, personalized learning experiences, and intelligent systems for classroom management and administration (Harris & Jones, 2019). Within this framework, AI leadership reflects the ability of school leaders and teachers to strategically implement these technologies to enhance teaching, learning, and management outcomes. By developing AI leadership, schools gain advantages in making data-informed decisions,

implementing adaptive teaching strategies, and improving student outcomes, as these competencies enable educators to monitor student achievement and tailor learning experiences effectively. Hence, AI leadership acts as a mediating variable that connects digital culture, teacher competence, and teacher leadership with student academic performance the ultimate goal of educational transformation.

In Indonesia, particularly in Muaro Jambi Regency, the integration of digital technology in education is progressively being implemented through school digitalization programs. Muaro Jambi Senior High School is one of the institutions actively adopting AI-assisted learning platforms and digital administration systems. However, despite these initiatives, challenges remain regarding teachers' AI competence, digital readiness, and leadership adaptation to technology-driven instruction. These contextual dynamics make the school an ideal setting for examining the interrelationships among digital culture, teacher AI competence, teacher leadership, AI leadership, and student academic performance.

Building on this background, it is clear that effectively integrating AI into education relies not only on technological infrastructure but also on educators' competencies, leadership capabilities, and the school's existing digital culture. Although digital tools and AI-assisted learning platforms are increasingly being implemented, there is still a pressing need to investigate how digital culture, teacher AI competence, and teacher leadership interact to shape AI leadership and, ultimately, influence student academic outcomes. Consequently, this study aims to explore the interrelationships among these factors at Muaro Jambi Senior High School, offering both theoretical contributions to understanding AI-based educational leadership and practical recommendations to enhance teacher professional development, school innovation, and student learning in the era of technology-driven educational transformation.

This study investigates the influence of digital culture, teacher AI competence, and teacher leadership on student AI leadership and academic performance in the context of digital transformation in education at Senior High School in Muaro Jambi. Although the topic of digital culture and AI integration in education has been extensively researched (*e.g.* Wulan Ayu & Fitriyanto, 2022; Rasdiana *et al.*, 2024), there is still a significant knowledge gap related to the interrelationships among digital culture, teacher AI competence, teacher leadership, and AI leadership, particularly in the Indonesian context, where digital readiness and teacher leadership adaptation are still evolving. This study aims to fill this gap through an investigation of how these factors interact to shape AI leadership and academic performance in schools, by answering the following questions: (1) How does digital culture influence teacher AI competence and teacher leadership? (2) What is the impact of teacher AI competence and leadership on student AI leadership? (3) How do these factors collectively affect student academic performance? By integrating the extended Technology Acceptance Model (TAM) and using Partial Least Squares Structural Equation Modeling (PLS-SEM), this study provides not only theoretical contributions to the understanding of AI-based educational leadership but also practical implications for educators, policymakers, and school administrators to strengthen digital culture, enhance teacher competencies, and improve student outcomes in the era of technology-driven educational transformation.

LITERATUR REVIEW

Theoretical Foundation

Digital transformation in education is shaped by a combination of technological infrastructure, teacher competencies, leadership capacities, and the prevailing digital culture. The concept of digital culture emphasizes shared values, behaviors, and interaction patterns that facilitate collaboration, innovation, and ethical use of technology in schools (Wulan Ayu & Fitriyanto 2022; Rasdiana et al. 2024). A strong digital culture fosters adaptive mindsets and enables both teachers and students to effectively engage with emerging technologies. Teacher AI competence has emerged as a critical factor in technology-driven educational environments. Teachers who can understand, integrate, and apply AI technologies can personalize learning experiences, analyze student performance data, and enhance overall instructional effectiveness (Filiz *et al.*, 2025; & Mohamed *et al.*, 2025). Equally important is teacher leadership, which promotes innovation, guides peers in pedagogical transformations, and bridges the gap between policy and practice in digital learning environments (Ghamrawi *et al.*, 2024)

AI leadership functions as a central mechanism linking digital culture, teacher competencies, and teacher leadership to student academic performance. It reflects the strategic use of AI technologies by school leaders and teachers to support data-driven decision-making, adaptive teaching, and learning improvement (Harris & Jones (2019) Studies indicate that effective AI leadership not only mediates the relationship between school factors and learning outcomes but also contributes to the sustainable integration of AI in educational settings.

This study draws upon the Technology Acceptance Model (TAM) (Davis *et al.* 1989) to understand how teacher perceptions, motivations, and contextual factors influence the adoption of AI-based educational tools. TAM provides a theoretical foundation for analyzing how individuals' attitudes and perceived usefulness of technology shape their intention to use it. By integrating digital culture, teacher AI competence, and teacher leadership within this framework, the study offers a comprehensive perspective for understanding the mechanisms that drive AI leadership and, ultimately, affect student academic performance. Based on the theoretical foundation discussed above, the research model of this study is presented in Figure 1. The model illustrates the relationships between digital culture, teacher AI competence, teacher leadership, student AI leadership, and student academic performance.

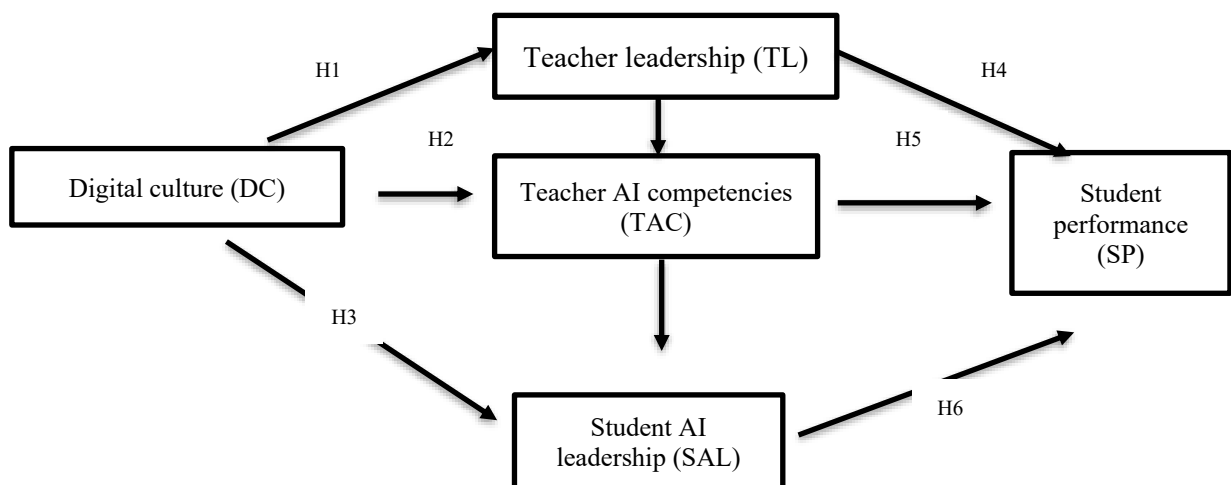


Figure 1. The Research Model

The proposed research framework (Figure 1) illustrates the conceptual relationships among Digital Culture (DC), Teacher Leadership (TL), Teacher AI Competencies (TAC), Student AI Leadership (SAL), and Student Performance (SP). In this model, Digital Culture functions as the foundation that shapes teachers' and students' behaviors in integrating technology and artificial intelligence (AI) into educational environments. A well-established digital culture encourages teachers to adopt innovative learning practices, enhances their leadership abilities, and empowers students to use AI tools effectively (H1–H3). This view is supported by research emphasizing that digital culture promotes collaboration, adaptability, and innovation in schools (Manca, 2020; Pérez-López *et al.*, 2021).

Teacher Leadership (TL) represents the teachers' ability to guide, influence, and inspire both their colleagues and students in implementing technology-based learning. Digital Culture is expected to have a positive impact on Teacher Leadership (H1), as teachers operating in digitally supportive environments tend to demonstrate stronger leadership in integrating AI. Furthermore, Teacher Leadership is hypothesized to influence both Teacher AI Competencies (H4) and Student Performance (H5), reflecting the central role of leadership in shaping effective learning processes and outcomes (Ng, 2021; Harris & Jones, 2020).

Teacher AI Competencies (TAC) refer to teachers' technical, pedagogical, and ethical skills in applying AI technologies in educational practices. A strong digital culture (H2) and effective leadership (H4) are predicted to enhance teachers' AI competencies, enabling them to design adaptive, AI-driven learning experiences that improve Student Performance (H5) and stimulate Student AI Leadership (H6). This aligns with studies by Krause *et al.* (2025) and Uskov *et al.* (2023), which highlight that teachers' competence in AI supports personalized instruction and higher learning achievement.

Meanwhile, Student AI Leadership (SAL) reflects students' capacity to use AI tools creatively, ethically, and collaboratively to support their learning. This variable is influenced by Digital Culture (H3) and Teacher AI Competencies (H6), indicating that a digitally supportive environment and competent teachers both play crucial roles in nurturing students' AI literacy and leadership (Chen *et al.*, 2024). In turn, students with strong AI leadership skills are expected to achieve higher Student Performance (H7), as they can engage more effectively in digital learning ecosystems.

Ultimately, Student Performance (SP) is the model's final outcome. The framework demonstrates how Digital Culture, mediated through Teacher Leadership, Teacher AI Competencies, and Student AI Leadership, collectively enhance students' academic success. This integrated approach underscores the synergy between technological adaptation, AI literacy, and leadership as key factors in advancing educational excellence in the digital transformation era.

Digital Culture (DC)

Digital culture is an important element that underpins educational transformation in the era of modern technology. Digital culture in education also has significant implications for the development of essential skills for the 21st century (Demuner *et al.* 2024). This concept reflects a set of values, attitudes, and behaviors shaped using digital technology in learning activities and educational management. In the school context, digital culture is not only about the use of technological tools but also about changes in mindset, work systems, and social interactions within the learning environment. A strong digital culture fosters the creation of an adaptive, innovative, and collaborative educational environment. Fitri & Kinkin Siti Sa (2024), stated that a collaborative learning culture in the digital age can increase student engagement and motivation to learn, strengthen social skills, and promote creative and innovative problem-solving. Digital culture provides opportunities for teachers

and students to use technology effectively to support innovative learning aligned with the demands of the modern era. Schools that successfully maintain a strong digital culture tend to show greater readiness to integrate artificial intelligence (AI) devices into teaching and administration. Therefore, strengthening digital culture in schools is essential to prepare teachers and students for the demands of AI-based education.

H1: Digital Culture (DC) has a positive and significant effect on Teacher Leadership (TL).

H2: Digital Culture (DC) has a positive and significant effect on Teacher AI Competencies (TAC).

H3: Digital Culture (DC) has a positive and significant effect on Student AI Leadership (SAL).

Teacher Leadership (TL)

In the context of modern education, teachers are expected not only to serve as instructors but also as instructional leaders who can foster a collaborative culture and encourage their peers to innovate. According to Gaol & Nababan (2019), teacher's leadership is a process that influences students to achieve learning objectives. Furthermore, according to Meilasari (2022), a teacher's leadership style refers to the behaviors or actions a teacher employs in their teaching, adjusted according to the needs and characteristics of the students.

Teachers with strong leadership skills play a crucial role in implementing school policies, fostering positive relationships among educators, and cultivating an effective spirit of teamwork. In the digital era, this leadership also involves integrating technology and promoting digital transformation within the school environment. The synergy between digital competence, creativity, and professional responsibility is essential in addressing the challenges of 21st-century learning. In this context, a teacher as a classroom leader must continually strive to expand their knowledge and study the changes and developments in the learning process, so that they can adjust student guidance according to actual needs and circumstances (Muhammad, 2017).

H4: Teacher Leadership (TL) has a positive and significant effect on Student Performance (SP).

Teacher AI Competence (TAC)

In the context of 21st-century learning, teachers are expected to develop AI literacy that includes an understanding of basic AI concepts, the ability to use intelligent systems to analyze student learning data, and the application of algorithms and AI-based tools to create adaptive and personalized learning experiences. Teachers with strong AI competence can effectively use technologies such as learning analytics, chatbots, and adaptive learning systems to identify students' needs and provide timely feedback. Teacher competence in artificial intelligence (AI) can be defined as the ability to understand, utilize, and effectively integrate AI-based technologies into the learning process and educational activities.

Several studies have shown that mastering AI competence is essential for teachers to improve the effectiveness of technology-integrated learning. Delcker *et al.* (2025) developed an instrument to measure teachers' perceptions of their AI competencies and found that most teachers still have varying perceptions of competencies, especially on the ethical dimensions and design of AI-based learning. Other research, by Chiu *et al.* (2025) emphasizes that teachers' confidence in using AI directly impacts their readiness to integrate this technology into their teaching practices.

Overall, teachers' competence in artificial intelligence (AI) plays a crucial role in fostering digital leadership in schools and ensuring the successful implementation of AI-based learning. Teachers who can effectively utilize AI not only enhance the efficiency and quality of instruction but also contribute to the development of an innovative and collaborative culture within the educational environment.

H5: Teacher AI Competencies (TAC) have a positive and significant effect on Student Performance (SP).

Student AI Leadership (SAL)

According to Harris & Jones (2023), leadership is essentially about building meaningful relationships and demonstrating empathy toward others. It involves understanding people's needs, inspiring them to reach their potential, and guiding them toward a collective vision with integrity and compassion. AI technologies, such as intelligent tutoring systems, automated grading systems, and predictive analytics, can significantly improve the accuracy and efficiency of assessments while providing personalized learning experiences for students (Ucheagwu - Okoye & Maryqueen, 2025). In the context of education, this concept extends to student AI leadership, where students are encouraged to develop the ability to lead, collaborate, and make informed decisions by using artificial intelligence technologies to solve problems and enhance learning outcomes. For example, a study by Krause *et al.* (2025) identified 14 essential skills that students need to interact with generative AI in education effectively. These skills include AI literacy, critical thinking, and ethical AI practices. The study highlights the importance of integrating AI into education while ensuring equitable access, clear academic integrity policies, and promoting inclusive and responsible global AI research initiatives.

H6: Student AI Leadership (SAL) has a positive and significant effect on Student Performance (SP).

Student Performance (SP)

In the context of formal education, assessing students' academic performance is essential. According to Muhammad (2017) Academic performance is the results achieved (achievement) or obtained through the academic learning process (academic achievement), which can be used to measure the extent to which students have mastered the material taught and learned. The measurement of academic performance not only serves as an indicator of learning success but also provides a basis for teachers and educational institutions to design more effective teaching strategies.

Sa & Ariati (2018) added that academic performance can be achieved if students view schooling as an opportunity to attain achievement by engaging in the emotional, behavioural, and cognitive aspects of learning. Students will reach optimal academic performance when they perceive learning activities as opportunities for self-development and actively participate in the cognitive, emotional, and behavioural aspects of learning. By understanding students' academic achievements, teachers can provide appropriate interventions, motivate students, and adjust teaching methods to make the learning process more effective (Slavin, 2014). This enables each student to learn more focusedly, improve their skills and understanding of the material, and reach their academic potential to the fullest.

METHODS

Data collection and participants

This study employed a quantitative, survey-based approach to collect data from students at Senior High School in Muaro Jambi. The population comprised all students enrolled in the 2024/2025 academic year. Given that the study focused on students with experience using AI-based learning platforms and digital technologies, purposive sampling was used to select participants who met the inclusion criteria. These criteria included: (1) active involvement in AI-assisted learning activities, (2) knowledge of and experience with digital learning platforms, and (3) willingness to participate in the study.

A total of 250 students were invited to participate, and 200 valid responses were obtained after screening for completeness and consistency. The demographic profile of the participants included variables such as gender, grade level, and prior experience with AI or digital technologies, which were taken into account in the analysis to control for potential confounding effects.

Data were collected from September to October 2025, using a Google Form-based questionnaire. The collected data were exported to Microsoft Excel for coding prior to analysis using SmartPLS. With support from academic colleagues at the school, the questionnaire link was disseminated across various online learning platforms, and teachers were asked to provide regular reminders to students to increase participation.

Measures

Information on respondents' demographics was collected in the first section of the questionnaire, while the second section comprised 21 items designed to measure the constructs of the research model. The questionnaire items were adopted from previously published literature and adjusted to suit the context of this study. A five-point Likert scale ranging from 1 "strongly agree" to 5 "strongly disagree" was used to assess each item. The questionnaire was made available in both Indonesian and English to ensure accessibility for all respondents.

Table 1. Participants' profile (N= 200)

Demographic		Frequency	%
Gender	Male	152	51%
	Female	148	49%
Age (Years)	<20	173	57%
	20 - 30	35	12%
	>30	92	31%
Education level	Senior high school	173	58%
	Undergraduate	102	42%

The respondents' demographic characteristics were analyzed to provide an overview of the sample composition. As presented in Table 1, the respondents comprised male and female students, with 152 males (51%) and 148 females (49%), indicating a relatively balanced gender distribution. Regarding age, the majority of respondents were under 20 years old (173 respondents, 57%), followed by those aged over 30 years (92 respondents, 31%), and a smaller proportion aged 20-30 years (35 respondents, 12%). In terms of education level, most participants were senior high school students (173 respondents, 58%), followed by undergraduate students (127 respondents, 42%). These results demonstrate a diverse demographic representation across gender, age, and educational backgrounds, providing a suitable basis for further analysis in this study.

Data analysis

The partial least squares structural equation modelling (PLS-SEM) technique was chosen for data analysis. In fact, PLS-SEM is a flexible approach that may be employed in a wide variety of settings, and whose sample size and distribution requirements are less conservative than those of other modelling techniques (Hair *et al.*, 2019). We used SmartPLS 4 (version 4.0.9.9) to analyze the data in this study. As instructed, we conducted the data analysis in two steps (Anderson & Gerbing, 1988). In step one, we evaluated the measurement model by assessing the internal consistency and convergent and discriminant validity. Since the data from the previous step were acceptable, we applied the structural

model to verify our hypothesis in step two. It is necessary to explain clearly how to interpret the data obtained in relation to the problems and research objectives.

FINDINGS AND DISCUSSION

Findings

Preliminary data analysis

The possibility of multicollinearity and common method bias (CMB) were examined prior to data analysis. To assess multicollinearity, the *Variance Inflation Factor* (VIF) was computed for all constructs in the inner model. According to Hair, *et al.* (2022), each VIF value should be below 3 to indicate the absence of multicollinearity. In this study, the VIF values ranged from 1.000 to 3.595 (see Table 2). Although one construct (Teacher Leadership) showed a VIF slightly above 3, it was still considered acceptable, as values below 5 are generally tolerated in social science research (O'Brien, 2007). Therefore, it can be concluded that no serious multicollinearity issue exists among the constructs. To further ensure the robustness of the model, Harman's single-factor test was conducted to examine the presence of common method bias (CMB). The results showed that all measurement items loaded onto a single factor accounted for 44.678% of the total variance, which is below the 50% threshold recommended by Podsakoff *et al.* (2003). This finding confirms that CMB is not a concern in this dataset.

Table 2. Multi-collinearity assessment

Construct	DC	SAC	SP	TAC	TL
DC	-	1.934	-	1.688	1.000
SAC	-	-	3.119		
SP	-	-	-		
TAC	-	1.934	2.224		
TL	-	-	3.595	1.688	

Measurement model

Before examining the proposed hypotheses, the reliability and validity of the measurement items (indicators) and scales (constructs) were tested (Hair *et al.*, 2019). First, the loading of each indicator was assessed. A loading ≥ 0.603 indicates an acceptable item loading. Table 3 shows that the loading of each item exceeds the recommended value, suggesting that all items exhibit adequate item reliability. Second, two measures were used to evaluate the internal consistency: Cronbach's Alpha (α) and composite reliability (CR). The minimum acceptable value of α and CR is recommended to be 0.4 and should not be ≥ 0.88 . This condition is satisfied by all constructs (see Table 3), indicating that internal consistency is present in all constructs. Third, the convergent validity was determined by examining the "average variance extracted - AVE". The minimum acceptable AVE value is 0.5., as can be seen in Table 3, the AVE value of each construct substantially exceeded 0.5, demonstrating that convergent validity exists in all constructs. In addition, the assessment of cross-loadings demonstrates that the items load substantially on their intended constructs, thereby confirming convergent validity.

Table 3. Internal and convergent validity assessment

Construct	Item	Loading	Cronbach's Alpha (α)	rho_A	Composite reliability (CR)	AVE
Digital Culture (DC)	DC1	0.772	0.822	0.827	0.875	0.585
	DC2	0.779				
	DC3	0.800				
	DC4	0.760				
	DC5	0.709				
Student AI Leadership (SAL)	SAL1	0.761	0.761	0.773	0.862	0.676
	SAL2	0.866				
	SAL3	0.836				
Student Performance (SP)	SP1	0.603	0.407	0.424	0.714	0.457
	SP2	0.771				
	SP3	0.644				
Teacher AI Leadership (TAC)	TAC1	0.754	0.739	0.747	0.835	0.560
	TAC3	0.671				
	TAC4	0.781				
	TAC5	0.782				
Teacher Leadership (TL)	TL1	0.907	0.836	0.839	0.884	0.603
	TL2	0.894				
	TL3	0.890				
	TL4	0.892				
	TL5	0.899				

Structural model

After obtaining a satisfactory assessment of the measurement model, the next step was to assess the structural model. The significance of the path coefficients (β) was first evaluated. Digital Culture (DC) exerted the strongest positive effect on Teacher Leadership (TL) ($\beta = 0.638$, $p < 0.001$), followed by Student AI Leadership (SAL) ($\beta = 0.429$, $p < 0.001$) and Teacher AI Leadership (TAC) ($\beta = 0.367$, $p < 0.001$). These results demonstrate that DC plays a crucial role as a key enabler of leadership development in both teachers and students. In contrast, the direct effects of TL, TAC, and SAL on Student Performance (SP) were positive but statistically insignificant (TL \rightarrow SP: $\beta = 0.165$, $p > 0.05$; TAC \rightarrow SP: $\beta = 0.134$, $p > 0.05$; SAL \rightarrow SP: $\beta = 0.031$, $p > 0.05$). This indicates that while digital culture significantly promotes leadership and AI-related competencies, these factors do not directly translate into measurable student performance outcomes. With respect to predictive power (R^2), DC, TL, TAC, and SAL jointly explained a substantial portion of variance in the model. Specifically, DC explained 63.8% ($R^2 = 0.638$) of the variance in TL, 36.7% ($R^2 = 0.367$) in TAC, and 42.9% ($R^2 = 0.429$) in SAL. Meanwhile, TL, TAC, and SAL collectively accounted for 37.2% ($R^2 = 0.372$) of the variance in SP, indicating a moderate explanatory power. According to Henseler et al. (2009), this level of explanatory power suggests that while the model effectively predicts leadership-related constructs, additional variables—such as instructional quality, motivation, or digital pedagogy—may be needed to fully explain student performance outcomes.

Overall, the structural model highlights Digital Culture as the central driving force shaping AI-related leadership among teachers and students. However, translating these competencies into tangible improvements in student performance may require long-term implementation, pedagogical integration, and support systems to bridge the gap between digital leadership and learning outcomes.

Table 4. Discriminant validity

	DC	SAL	SP	TAC	TL
DC					
SAL	0.880				
SP	0.511	0.460			
TAC	0.877	0.908	0.505		
TL	0.758	1.034	0.483	0.922	

Table 5. Hypothesis testing

Hypothesis	Path	β	Mean	STDEV	T Statistics	P Values
H1	DC \rightarrow TL	0.638	0.638	0.046	14.019	0.000
H2	DC \rightarrow TAC	0.367	0.367	0.060	6.078	0.000
H3	DC \rightarrow SAL	0.429	0.427	0.061	6.988	0.000
H4	TL \rightarrow SP	0.165	0.169	0.120	1.379	0.168
H5	TAC \rightarrow SP	0.134	0.135	0.091	1.471	0.141
H6	SAL \rightarrow SP	0.031	0.032	0.112	0.278	0.781

Table 6. Assessment of predictive power and predictive relevance

Construct	R ²	Assumption	Q ²	Assumption
SAL	0.581	Substantial	0.397	Large
SP	0.093	Weak	0.035	Small
TAC	0.626	Substantial	0.338	Medium
TL	0.407	Moderate	0.237	Mediuml

With respect to predictive power (R^2), the effects of exogenous constructs on the endogenous variables are summarized in Table 6. The results reveal that the model explained 58.1% of the variance in Student AI Leadership (SAL) ($R^2 = 0.581$), indicating a substantial explanatory power. Likewise, Teacher AI Leadership (TAC) showed a strong level of predictability with an R^2 of 0.626, also categorized as substantial. Teacher Leadership (TL) recorded a moderate explanatory power ($R^2 = 0.407$), while Student Performance (SP) had a relatively weak explanatory power ($R^2 = 0.093$). These findings indicate that while the model strongly predicts leadership-related constructs, additional factors may be required to better explain student performance outcomes.

The results of assessing predictive relevance (Q^2) are also presented in Table 6. According to the results, all dependent variables demonstrated predictive relevance ($Q^2 > 0$). Specifically, the Q^2 value for SAL was 0.397, indicating strong predictive relevance, while TL ($Q^2 = 0.237$) and TAC ($Q^2 = 0.338$) exhibited moderate predictive relevance. In contrast, SP showed a small predictive relevance ($Q^2 = 0.035$). These findings confirm that the structural model has adequate predictive capability, especially for leadership-related constructs, while its predictive power for student performance remains limited.

Table 7. Effect size assessment (Cohen, 1988)

Construct	DC	SAL	SP	TAC	TL
DC		0.231		0.213	0.688
SAL			0.000		
SP					
TAC		0.201	0.008		
TL			0.008	0.403	

Table 8. Indirect Effects Assessment

Construct	Item	Loading	Cronbach's Alpha (α)	rho_A	Composite reliability (CR)	AVE
Digital Culture (DC)	DC1	0.772	0.822	0.827	0.875	0.585
	DC2	0.779				
	DC3	0.800				
	DC4	0.760				
	DC5	0.709				
Student AI Leadership (SAL)	SAL1	0.761	0.761	0.773	0.862	0.676
	SAL2	0.866				
	SAL3	0,836				
Student Performance (SP)	SP1	0.603	0.407	0.424	0.714	0.457
	SP2	0.771				
	SP3	0.644				
Teacher AI Leadership (TAC)	TAC1	0.754	0.739	0.747	0.835	0.560
	TAC3	0.671				
	TAC4	0.781				
	TAC5	0782				
Teacher Leadership (TL)	TL1	0.907	0.836	0.839	0.884	0.603
	TL2	0.894				
	TL3	0.890				
	TL4	0.892				
	TL 5	0.899				

Indirect effect assessment

The significance of the indirect effects of the research model's constructs is shown in Table 8. The results indicate that most indirect effects were significant, with the exception of the indirect effects of Digital Culture (DC) and Teacher Leadership (TL) on Student Performance (SP) through Student AI Leadership (SAL) and Teacher AI Competence (TAC). DC on TAC produced the most substantial indirect effect through TL ($\beta = 0.234$, $p < 0.001$), indicating that a strong digital culture within the school significantly enhances teachers' leadership capacity, which in turn improves their AI competence. In contrast, DC on SP through TL generated the weakest indirect effect ($\beta = 0.105$, $p = 0.174$). Interestingly, while the direct effect of DC on SP was insignificant (see Table 5), the indirect effects of DC on SAL ($\beta = 0.157$, $p < 0.001$) and on TAC ($\beta = 0.234$, $p < 0.001$) were significant. This suggests that digital culture enhances student AI leadership and teacher AI competence, even if its direct influence on performance outcomes is limited.

Furthermore, the indirect effect of TL on SAL through TAC ($\beta = 0.173$, $p < 0.001$) was significant, implying that effective teacher leadership can foster student AI leadership by strengthening teachers' own AI competence. However, the indirect effects of DC, TL, and TAC on SP through multi-step paths such as DC \rightarrow TL \rightarrow TAC \rightarrow SP and TL \rightarrow TAC \rightarrow SAL \rightarrow SP were insignificant ($p > 0.05$).

These findings suggest that leadership and competence development serve as crucial mediating processes, in which digital culture and teacher leadership indirectly enhance students' performance by first building teachers' and students' AI-related capacities. In short, the indirect relationships in this model are stronger in leadership and competence formation, while their effects on student academic performance remain indirect and gradual. The findings respond to the study's purpose and are presented systematically. Sufficient and relevant quotations, examples, tables, and diagrams support them.

Discussion

The findings demonstrate that Digital Culture (DC) significantly and positively affects Teacher Leadership (TL), Teacher AI Competence (TAC), and Student AI Leadership (SAL), thus supporting H1, H2, and H3, respectively. This result aligns with previous research that emphasizes digital culture as the foundation for successful educational transformation (Rasdiana *et al.*, 2024a; Wulan Ayu & Fitriyanto 2022). A strong digital culture enhances openness to technological innovation and encourages teachers and students to engage collaboratively with AI-based learning. Schools with a well-established digital culture foster environments where both educators and learners actively use digital tools, exchange ideas, and innovate in learning practices. Consequently, teachers in digitally mature schools are more likely to demonstrate strong leadership in integrating technology and promoting AI-related initiatives.

Furthermore, digital culture was found to have a substantial influence on Teacher AI Competence (TAC). This finding supports the notion that a positive digital environment motivates teachers to enhance their technological and AI skills continually. Similar findings were reported by Filiz *et al.* (2025) who highlighted that teachers in collaborative, digitally supportive school cultures are more confident and capable of using AI to improve pedagogical practices. Teachers in such settings tend to perceive AI not merely as a technical tool but as an enabler of data-driven, personalized, and adaptive learning experiences. This strengthens the argument that cultivating a strong digital culture is a prerequisite for developing competent, AI-literate teachers who can effectively integrate intelligent systems into classroom instruction.

In addition, Digital Culture exerts a significant positive effect on Student AI Leadership (SAL), indicating that it also shapes students' ability to use AI tools creatively, ethically, and

collaboratively. This aligns with the results of Krause *et al.* (2025), which suggest that digitally rich environments enhance students' AI literacy and leadership potential. When schools promote openness, experimentation, and ethical use of technology, students become more confident in exploring AI-based tools for problem-solving and innovation. Such environments empower students to view AI as a medium for critical thinking, collaboration, and responsible digital citizenship.

However, the findings reveal that the direct effects of Teacher Leadership (TL), Teacher AI Competence (TAC), and Student AI Leadership (SAL) on Student Performance (SP) were positive but not statistically significant, indicating that H4, H5, and H6 were not supported. These results suggest that while leadership and AI competence are crucial for fostering innovation and readiness, their immediate impact on measurable academic performance is limited. This may be due to several contextual factors. First, the integration of AI-based learning in schools like Muaro Jambi Senior High School is still in the early stages, and the benefits on student outcomes may take time to materialize. Second, academic performance is influenced by multiple variables—such as instructional quality, learning motivation, and assessment design—that may moderate or mediate the relationship between leadership variables and performance. This finding is consistent with research by Ng (2021) and Harris & Jones (2019), who noted that the effects of educational leadership often manifest indirectly through pedagogical quality and school climate rather than directly influencing test-based performance.

The findings on predictive power further support this interpretation. The model demonstrated substantial explanatory power for Teacher AI Competence ($R^2 = 0.626$) and Student AI Leadership ($R^2 = 0.581$), and moderate explanatory power for Teacher Leadership ($R^2 = 0.407$). In contrast, Student Performance (SP) recorded only weak explanatory power ($R^2 = 0.093$), suggesting that the model predicts leadership-related constructs more effectively than performance outcomes. This reinforces the idea that digital culture and AI leadership development are antecedent conditions for long-term improvements in learning outcomes but not immediate predictors of academic achievement. The predictive relevance (Q^2) values also provide insight into the model's performance. Student AI Leadership ($Q^2 = 0.397$) demonstrated large predictive relevance, while Teacher AI Competence ($Q^2 = 0.338$) and Teacher Leadership ($Q^2 = 0.237$) exhibited medium predictive relevance. Student Performance, however, showed small predictive relevance ($Q^2 = 0.035$), confirming that while the model has strong predictive capability for leadership dimensions, additional mediating or moderating factors may be necessary to improve its predictive strength for academic outcomes.

Overall, the discussion underscores that Digital Culture is the central enabling factor driving the development of AI leadership among teachers and students. It cultivates the values, attitudes, and collaborative behaviors necessary for successful AI integration in education. However, translating these digital and leadership competencies into tangible improvements in student academic performance requires sustained implementation, capacity-building initiatives, and pedagogical alignment. Future research could investigate mediating mechanisms such as instructional innovation, digital pedagogy quality, and student engagement, as well as the moderating effects of access to digital infrastructure and institutional support. These additional factors may explain how AI leadership and digital culture jointly influence student learning outcomes in technology-driven education systems.

Implications

The contribution of this study is recognized to be twofold. The first is theoretical. This research advances the Technology Acceptance Model (TAM) by integrating digital culture, teacher leadership, and teacher AI competence to explain how schools adapt to artificial intelligence in education. Traditional TAM approaches have often been criticized for

emphasizing technological and enabling factors while overlooking human, social, and cultural dimensions. This study's novelty lies in its conceptual expansion of TAM through the inclusion of organizational culture and leadership as mediating forces that shape behavioral adaptation to AI-based education. By embedding these human-centered variables, the study provides a more holistic understanding of the mechanisms that drive the formation of AI competence and leadership among teachers and students.

The results confirm that digital culture functions as the primary enabler of leadership and competence development. A strong digital culture fosters collaboration, ethical awareness, and innovation—factors that collectively strengthen the readiness of both teachers and students to integrate AI technologies into educational practices. The findings also validate that teacher leadership and AI competence operate as critical mediators that connect digital culture to student AI leadership and academic outcomes. This theoretical refinement contributes to the growing literature on digital transformation in education, particularly by emphasizing that the path from technological readiness to academic achievement is neither direct nor instantaneous, but occurs through a network of leadership, competence, and cultural adaptation processes.

From a practical standpoint, the findings provide valuable insights for educational practitioners, policymakers, and school leaders seeking to implement AI-driven learning environments effectively. The study underscores that digital transformation cannot succeed solely through infrastructure or technology adoption; it requires cultivating a culture that embraces ethical use of technology, collaboration, and continuous professional learning. Schools should promote a shared digital vision in which teachers serve as role models and innovators, guiding students in responsible and creative use of AI. Strengthening teacher leadership is essential, as teachers who demonstrate AI competence and initiative can influence peers and students, accelerating the diffusion of digital innovation within the institution.

The research also highlights the importance of embedding AI literacy within teacher professional development programs. Teachers should be trained not only in technical skills but also in data interpretation, algorithmic transparency, and pedagogical strategies for personalized learning. Such capacity building transforms teachers from passive users of technology into reflective leaders who can integrate AI to improve instructional design and student engagement. Similarly, students must be encouraged to develop AI leadership through experiential, project-based, and ethical learning approaches that enable them to become active participants in the digital transformation of education.

Although the model's indirect effects on student performance were not statistically significant, this finding has important practical implications. The development of AI competence and leadership within schools is a long-term investment whose educational impact may only emerge over time as cultural, pedagogical, and structural changes become more integrated. Therefore, policymakers should align digital transformation initiatives with systemic support mechanisms, including digital infrastructure, curriculum innovation, and assessment reforms that capture higher-order learning outcomes enabled by AI technologies.

In essence, this study demonstrates that the successful adoption of AI in education depends less on the presence of technology itself and more on the synergy between digital culture, leadership empowerment, and competence development. Digital culture provides the moral and collaborative foundation, teacher leadership drives transformation through influence and example, and AI competence operationalizes innovation in classroom practice. Together, these dimensions form a coherent framework for building sustainable, human-centered digital transformation in education.

CONCLUSION

Conclusion and limitation

A modified Technology Acceptance Model (TAM) framework was developed in this study to investigate the key factors influencing the integration of artificial intelligence (AI) in education, with a focus on the interplay among digital culture, teacher leadership, and teacher AI competence. Using data collected from students at Muaro Jambi Senior High School, the research empirically examined how these constructs shape students' AI leadership and academic performance. The results demonstrated that digital culture exerts substantial positive effects on teacher leadership, teacher AI competence, and student AI leadership, confirming its central role as the foundational driver of digital transformation in education. Moreover, the indirect effects revealed that digital culture influences student outcomes primarily by enhancing teacher leadership and competence, highlighting the importance of leadership and capability development as mediating mechanisms.

Although the direct effects of teacher leadership, teacher AI competence, and student AI leadership on student performance were statistically insignificant, their positive associations indicate that these factors contribute indirectly to the development of the necessary conditions for improved learning outcomes over time. The findings suggest that translating AI-related leadership and competence into measurable academic success requires a long-term process of pedagogical adaptation, digital readiness, and cultural alignment within schools. Importantly, the study reinforces the idea that successful AI adoption in education depends on a synergy between technological infrastructure and the human dimensions of digital transformation—namely, culture, leadership, and competence. This research offers both theoretical and practical contributions to AI-integrated education. Theoretically, it extends the TAM framework by embedding social and cultural variables into the model, thereby enriching our understanding of how human and contextual factors shape technology-driven educational innovation. Practically, it provides actionable insights for policymakers and school leaders to prioritize digital culture development, leadership empowerment, and professional training in AI pedagogy as strategic levers for sustainable educational transformation.

Despite these valuable insights, several limitations must be acknowledged. First, the study was conducted in a specific educational context—Muaro Jambi Senior High School—which may limit the generalizability of the findings to other regions or educational levels. Future research should replicate and compare this model across settings, such as universities and vocational schools, to identify contextual similarities and variations. Second, this study relied on a cross-sectional survey design, which captures relationships at a single point in time. Longitudinal or experimental research could provide deeper insights into the causal effects of digital culture and AI leadership on learning outcomes as technological integration progresses. Third, the data were perception-based, which may not fully capture behavioural or performance-based outcomes. Incorporating objective measures such as academic analytics, AI usage logs, or performance tracking systems in future studies would enhance validity.

Additionally, future research could expand the model by introducing moderating variables such as gender, age, digital experience, or institutional support to examine how these factors influence the strength of relationships among constructs. Exploring the perspectives of teachers and school leaders themselves would also add valuable depth to understanding the systemic challenges and opportunities of AI adoption in education. In conclusion, this study underscores that the digital transformation of education is not merely a technological shift but a holistic cultural and leadership evolution. Building a robust digital culture, empowering teacher leadership, and enhancing AI competence are essential steps toward preparing students for meaningful participation and success in AI-driven learning ecosystems. Conclusions and implications for further implementations should be

provided. The study's theoretical implications and practical significance are discussed. Implications for further implementations, suggestions for further research, and limitations of the current study are provided.

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