Check for updates

The influence of school principals' digital leadership on teachers' competency in integrating artificial intelligence: a systematic thematic review

Meiyu Zeng, Kenny S. L. Cheah* and Zuraidah Abdullah

Faculty of Education, Universiti Malaya, Federal Territory of Kuala Lumpur, Malaysia

This systematic thematic review aimed to examine how the digital leadership of principals affects teachers' capacity to use artificial intelligence technology in their teaching. In this study, the Unified Theory of Acceptance and Use of Technology (UTAUT) is combined with transformational leadership theory to provide an analytical framework. Fourteen empirical papers published between 2021 and 2025 were identified from the Scopus, Web of Science, and ERIC databases following the PRISMA guidelines. By allocating resources, providing support for professional development, creating learning communities, and cultivating a positive culture, principals may significantly influence teachers' acceptance and use of AI technology. In addition to improving teachers' perceptions of the value and usability of AI technologies, effective leadership also greatly increase their technological self-efficacy and help them better integrate it. Key facilitators like the complementarity of dual leadership, incentives, and continuing professional development are identified in the study, even if AI integration still faces obstacles, including inadequate infrastructure, teacher reluctance to use AI, and a lack of organizational support. This research presents a theoretical integrative viewpoint for comprehending the acceptance of educational technology. It also offers theoretical justification and useful recommendations for leadership development, educational reform, and enhancing teachers' AI skills. It highlights the need for leadership in advancing AI integration and educational fairness in the context of the digital revolution of education.

KEYWORDS

digital leadership, AI integration, transformational leadership, UTAUT, professional development

1 Introduction

The application prospects of artificial intelligence in the field of education are broad. Customized teaching and intelligent tutoring are its main advantages as they can improve student performance while reducing the stress on educators. The use of AI does have some drawbacks, including security and privacy concerns. However, AI still has great potential in the field of education (Harry, 2023). In the context of digital transformation in education, principals' digital leadership is seen as a key factor in achieving successful technology integration. According to Ridho et al. (2023), principals can achieve digital leadership by continuously promoting change and providing opportunities for all staff to interact with and use digital technologies. Digital leadership is based on critical thinking,

innovation, communication, and cooperation. Therefore, establishing a culture that supports technology integration requires principles (AlAjmi, 2022).

A lack of systematic training, a lack of technological infrastructure, a lack of digital literacy among teachers, and the risk that an over-reliance on AI will stifle their creativity and ability to interact with others are some of the obstacles that still need to be overcome before incorporating AI into teacher education. Thus, proper planning and continuous assistance are necessary for the successful implementation of AI, and excellent leadership is associated with a greater use of technology in the classroom (Omidvar and Meihami, 2025). According to earlier research, teachers' perceptions of their principal's digital leadership influence the extent to which they use technology in the classroom (Mehmood, 2023), especially when it comes to newer technologies like artificial intelligence.

Additionally, visionary principals are better at inspiring teachers and making the most of digital resources, which promotes an innovative culture and influences teachers' readiness and proficiency to employ AI technology in the classroom (AlAjmi, 2022). According to Hamzah et al. (2021), principals in Hulu Langat, Malaysia, have successfully incorporated traits of digital leadership, such as visionary leadership style, into their school management and administration. A comprehensive and systematic understanding of the direct relationship between principals' leadership styles and the development of teachers' AI abilities is still absent, despite the rising amount of research on digital leadership (Muslim and Setyono, 2024). By filling this research gap, educational leaders will be better able to assist staff and teachers in addressing the challenges of incorporating AI, thereby improving teaching outcomes and educational practices.

Thus, this study's significance rests in its capacity to provide theoretical underpinnings and useful advice for the establishment of educational leadership policies as well as teacher professional development. This research may aid in the development of focused training programs and continuous support systems to improve teachers' capacity to scientifically incorporate AI technology into their instruction by examining the dynamic link between principals' digital leadership and teachers' AI proficiency. As emphasized by Gligorea et al. (2023) and Aghaziarati et al. (2023), in order to improve the efficiency, engagement, and personalization of instruction—and ultimately the learning experience for students—teachers should be able to use AI technologies and applications with flexibility.

2 Knowledge gap

The rapid development of AI technologies has enormous potential to improve teaching and learning procedures in educational settings. However, the adoption and use of these technologies by instructors is a critical component of the effective integration of AI in education. Effective use of AI in the classroom is severely limited by teachers' lack of technical expertise, poor training, and a lackluster support system (Omidvar and Meihami, 2025; Mehdaoui, 2024). Technological infrastructure, institutional regulations, and individual instructor attitudes have been the main subjects of previous studies. However, there is a lack of comprehensive research on school leadership styles, especially regarding how they influence students' abilities to use AI (Shal et al., 2024).

Indeed, instructors often struggle to handle the intricacies of artificial intelligence technologies on their own without deliberate facilitation. According to Fullan et al. (2024) the development of a vision driven by moral responsibility and strong support is crucial for school leadership in integrating artificial intelligence. The principal is at the center of the school's digital transformation and is directly involved in building the campus culture, professional development systems, and technology infrastructure. Karakose et al. (2021) noted that the principal is crucial in helping to build the school's digital learning culture, but AlAjmi (2022) stated that a teacher's ability to use technology effectively primarily depends on the principal's ability to give them a clear vision, adequate training, and resource guarantees.

While digitally transformative leaders use their skills to enhance teachers' capacity for innovation (Orunbon et al., 2023), research on how principals' digital leadership specifically impacts teachers' AI application skills remains relatively limited. Bridging this gap could help educational institutions develop more prepared and strategic leadership systems, thereby creating favorable conditions for the proper integration of AI in education.

3 Purpose of the study

To examine the influence of principals' digital leadership on teachers' proficiency in AI integration, offering practical recommendations for enhancing AI implementation in education.

4 Research questions

1. In what ways does the digital leadership of principals affect teachers' proficiency in AI integration?
2. What leadership practices are most effective in enhancing teachers' AI-related skills?
3. What barriers and facilitators exist in leadership-driven AI integration in schools?

5 Theoretical framework to guide the SLR

Two well-known theories, transformational leadership theory and the Unified Theory of Acceptance and Use of Technology (UTAUT), provide a comprehensive theoretical framework for understanding the integration of AI and education, as shown in Figure 1. This framework is particularly suitable for analysis from the perspective of principal leadership.

According to Bass (1985), transformational leadership is the process by which leaders use their charisma, intellectual stimulation, inspiring motivation, and individualized attention to inspire followers to strive for group objectives rather than individual ones. According to Bass (1990), this theory has four main components: idealized influence, which gives workers a sense of direction and serves as an example for the transformation process; inspirational motivation, which communicates high standards to workers and makes important points clear; intellectual stimulation, which encourages workers' creativity, critical thinking, and problem-solving abilities; and individualized consideration, which emphasizes
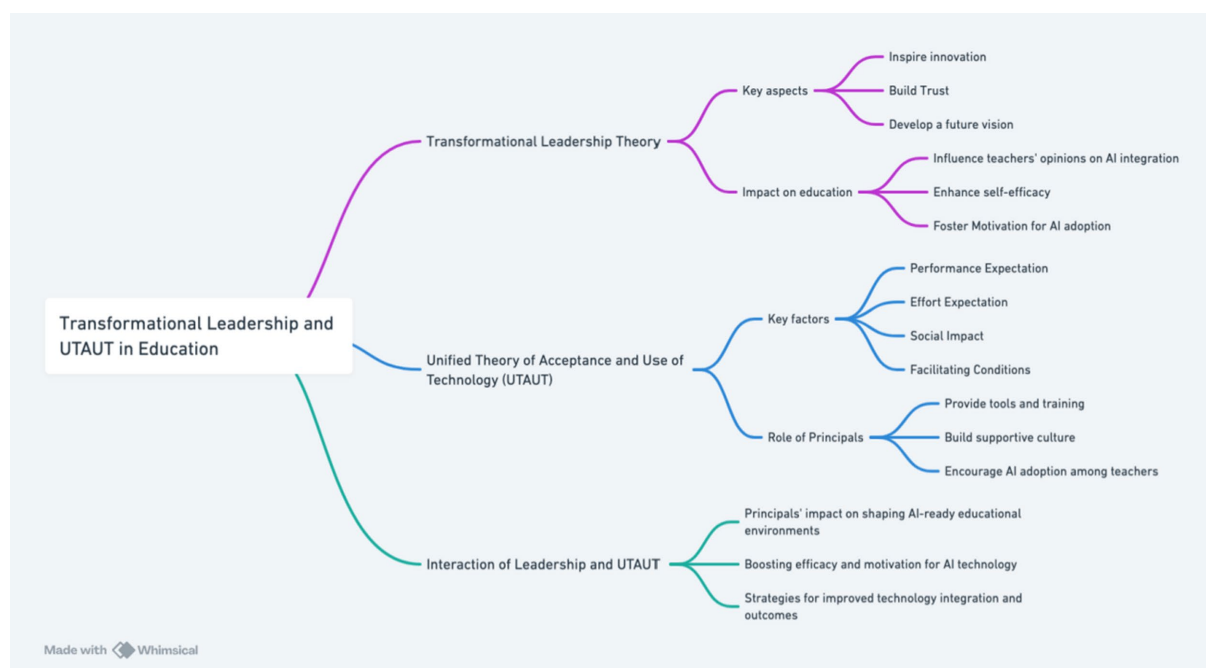
FIGURE 1
Framework of transformational leadership and UTAUT in education.

workers' uniqueness and offers direction and counsel. Transformational leadership, according to Leithwood and Jantzi (1999), may encourage organizational commitment and teacher competency in certain situations. According to Alzoraiki et al. (2023), transformational leadership improves teacher commitment. To build trust, encourage teacher communication, and cultivate an organizational commitment culture among their staff, they stress that leaders should use idealized influence. Furthermore, Lin et al. (2022) noted that in order to increase teacher self-efficacy and professional growth, school leaders must use transformational strategies. Incorporating artificial intelligence technology and transformational leadership ideas into the educational area will support the intelligent, individualized, and forward-looking development of instructional procedures (Hou et al., 2024).

Furthermore, UTAUT offers a framework for comprehending the elements of social impact (SI), performance expectation (PE), effort expectation (EE), and facilitating conditions (FC) that affect the adoption and utilization of technology in educational contexts (Venkatesh et al., 2003). SI refers to the degree to which an individual believes others expect them to use the new system. PE particularly describes the degree to which an individual believes that using a system would improve their performance at work. EE indicates the ease of using the system. FC refers to the extent to which individuals perceive that there is sufficient organizational and technical support to enable system use. These constructs are particularly critical in the educational context. In school settings, the principal's leadership style has a significant impact on these four variables. For example, leaders who provide teachers with adequate tools and continuous training can effectively enhance their awareness of the technical value and convenience of AI tools, thereby improving performance and effort expectations (AlAjmi, 2022). In addition, principals' ability to build a supportive culture for technology application (Karakose et al., 2021) may help promote positive social impacts, thereby motivating teachers to adopt AI technology in their daily work.

The integration of transformational leadership and UTAUT theory reveals the bridging role of principals in the AI integration process. The former emphasizes the role of principals in stimulating teachers' intrinsic motivation and shaping a positive culture, while the latter focuses on the psychological pathways of technology adoption. This will assist everyone in comprehending how leaders may encourage the use of sustainable technology through self-efficacy, cultural growth, and visionary leadership. Cheng and Wang (2023) stressed that to develop more forward-looking strategies for AI integration and enhance overall educational outcomes, educational leaders must not only support AI integration but also consider the balance between organizational culture, teacher motivation, and teaching effect.

Therefore, the principal's leadership style has a critical impact on the effective integration of AI in education. By applying transformational leadership concepts and understanding the impact pathways outlined by UTAUT, principals can not only enhance teachers' confidence and ability in using AI but also provide systematic support for the school's digital transformation. This study constructs an analytical framework based on these two theories and conducts a systematic literature review (as shown in Table 1) to advance research on the integration of educational leadership and AI. Transformational leadership theory emphasizes the importance of leaders in fostering visionary creativity and building trust, while the UTAUT model emphasizes the role of performance expectations, effort expectations, social influence, and a conducive environment. The combination of the two provides an integrated explanatory path for technology adoption behavior in education systems.

6 Methodology

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique's recommendations are followed by the SLR methodology used in this work (Rohman, 2024). When

TABLE 1 Eligibility and exclusion criteria.

Standard	Eligible	Excluded
Article type	Empirical articles	Books, book series, book chapters, systematic reviews, conference proceedings
Language	English	Non-English
Timeline	2021–2025	2021 and before
Country	World	/

researching digital leadership and AI integration capabilities, researchers may follow the PRISMA 2020 statement's recommendations for openness, consistency, and integrity (Sohrabi et al., 2021). SLR is a structured approach designed to systematically identify, evaluate, and analyze existing research to address specific research questions (Tian et al., 2018). Based on the PRISMA flowchart, as shown in Figure 2 (Page et al., 2021), this study systematically screened and synthesized relevant literature in four phases: identification, screening, eligibility review, and inclusion.

6.1 Identification of search terms

To ensure systematic research and transparency, this study conducted literature searches in three major databases: Scopus, Web of Science (WoS), and ERIC. As described by Santamaria-Granados et al. (2020), Scopus is a comprehensive database covering high-quality, multidisciplinary literature worldwide and is widely used for systematic literature reviews. Web of Science, the first comprehensive international bibliographic database, has gradually become a leading source of bibliographic data for journal screening, research evaluation, and bibliometric analysis (Li et al., 2018). Furthermore, ERIC is an authoritative full-text database focused on education, providing a wealth of research materials (Santhanasamy and Yunus, 2022).

Figure 2 illustrates the PRISMA flowchart used in this investigation. The identification step used a systematic approach to identify relevant sources (Hamid et al., 2024). Search terms were combinations of "digital leadership," "artificial intelligence," and "AI integration with educators." A total of 2,061 articles were initially retrieved, of which 130 were removed due to duplication, resulting in a final total of 1,931 articles included for subsequent screening and analysis. This research aims to provide a thorough evaluation and include many opinions.

6.2 Screening

The screening process is crucial to focus on literature sources that are highly relevant to the research topic (Hamid et al., 2024). During the screening phase, the research team conducted a preliminary evaluation of all potentially relevant literature based on the predefined research questions and standardized criteria, retaining only studies closely related to the integration of digital leadership and artificial intelligence. The screening criteria were tailored to the context and research area of this study. Using the inclusion and exclusion criteria listed in Table 1, the research team first screened the remaining literature based on title

and abstract. Inclusion criteria comprised: 1. Publication date: 2021–2025; 2. Empirical research within the domain of education. 2. This emphasis on empirical research guarantees that the analytical outcomes are grounded in objective facts and verifiable proof, thereby augmenting the practical significance and persuasiveness of the study. 3. Publication in the English language. A total of 1,880 items were removed as irrelevant throughout the screening process. All preserved papers were meticulously assessed based on established criteria and uniform rules to improve the openness and scientific integrity of the screening process. As Purnama et al. (2022) stated that, unified evaluation criteria not only help improve research quality but also effectively avoid implicit bias.

6.3 Eligibility

The third round of full-text review reviewed 51 papers in total. To make sure each publication was closely related to the study's goals and satisfied the inclusion requirements, the research team thoroughly examined each one. The study's subject, methodology, findings, theoretical framework, and other elements were thoroughly reviewed by the research team in order to accomplish this purpose. A total of 14 papers were chosen for data analysis after 37 irrelevant articles were eliminated. Figure 2 illustrates the procedures for screening the literature.

7 Data analysis

In the data analysis phase, the study team methodically examined and structured the relevant literature. Before analysis, researchers retrieved pertinent material from the chosen publications by using the study questions, concentrating on the abstracts, results, and discussion sections. They also evaluated extra chapters for supplemental resources. All extracted information was consolidated into data tables for inductive analysis. This research used thematic analysis to discern and categorize major topics about digital leadership and AI integration. This approach includes the identification, analysis, organization, description, and reporting of themes derived from the retrieved data (Braun and Clarke, 2006). The researchers created a preliminary coding table derived from the study questions and theoretical framework to synthesize key results, pulling pertinent material from the literature on leadership behaviors, teacher AI competence development, and technology integration. Following extensive examination and deliberation, the research team discerned three fundamental themes: (1) the influence of principal digital leadership on teacher AI proficiency; (2) leadership techniques for augmenting teacher AI integration; and (3) obstacles and enablers to AI integration. Throughout the coding process, two researchers conducted separate analyses and comparisons of theme structures, addressing discrepancies via dialogue. A third expert was solicited to evaluate the precision and logic of the theme framework, if required. The completed topic framework established the foundation for the organization of the ensuing research results chapters.

8 Research results

Figure 3 illustrates that the 14 core articles used in the analysis are strongly matched with the theoretical framework and research
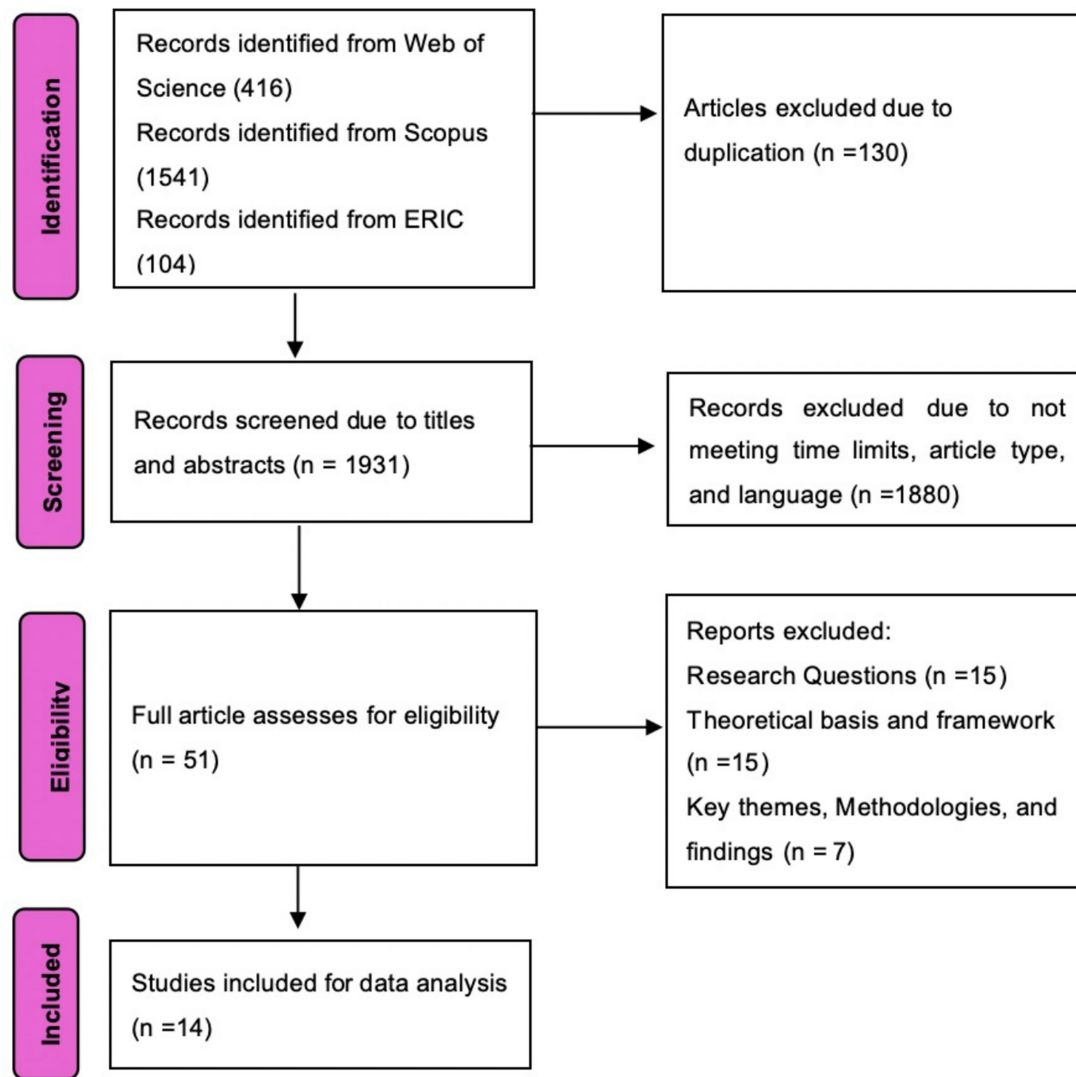
FIGURE 2
PRISMA-based approach utilized for the systematic literature review (SLR).

concerns of this study, concentrating mostly on transformational leadership and the Unified Theory of Acceptance and Use of Technology (UTAUT). The chosen publications examined the correlation between principals' digital leadership and teachers' integration of AI from many viewpoints, addressing critical subjects such as teacher capacity enhancement, leadership methodologies, organizational support, and institutional obstacles.

Three research topics are methodically addressed by the examination of this study. It begins by examining how principals' digital leadership affects teachers' capacity to incorporate AI technologies into their lessons. Secondly, it enumerates successful leadership techniques that improve educators' AI proficiency. It concludes by outlining the main obstacles and motivators that schools face as they work to advance AI integration. By providing theoretical support and practical consequences for educational leadership practice and policy creation, this systematic study not only defines the precise role of leadership behavior in AI

integration but also ensures the relevance and usefulness of the research aims.

8.1 Question 1: In what ways does the digital leadership of principals affect teachers' proficiency in AI integration?

The potential for pedagogical transformation presented by the incorporation of artificial intelligence (AI) into education is contingent upon the readiness and self-efficacy of educators. The principal's digital leadership has a big impact on teachers' capacity to incorporate AI. Halomoan et al. (2024) showed that principals' proactive coaching and AI-driven curricular innovation are positively correlated, suggesting that their leadership actions foster teacher creativity. Additionally, according to Antonopoulou et al. (2025), transformational leadership places a strong emphasis on rewards and
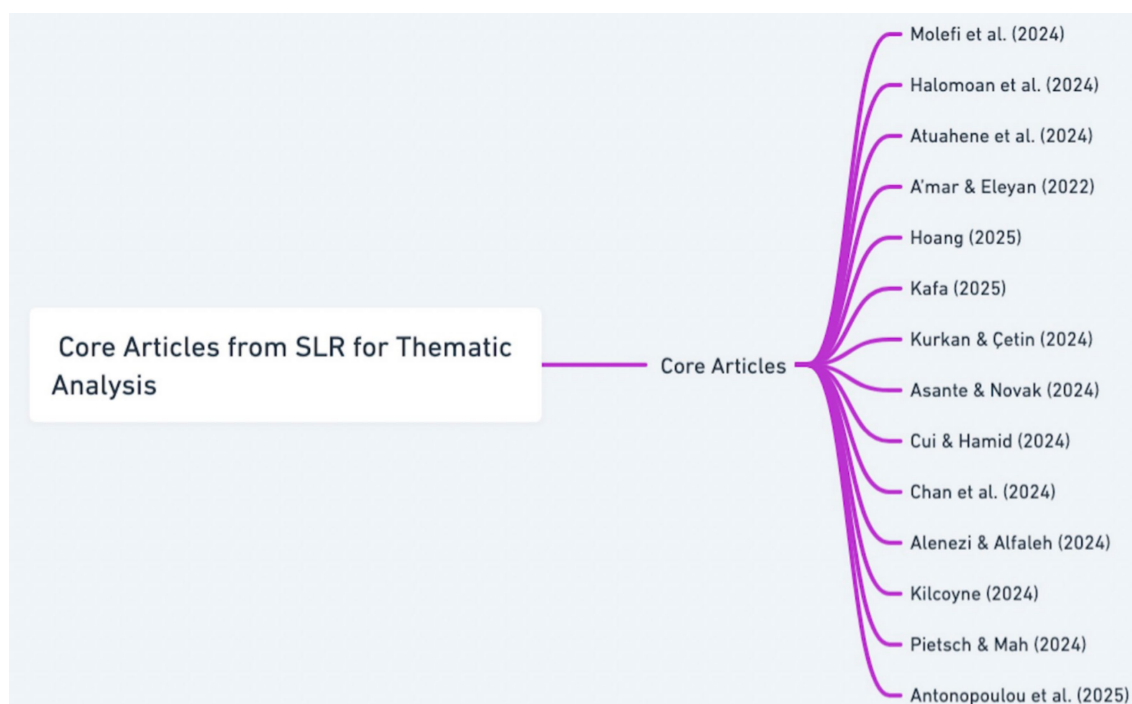
FIGURE 3
Core articles for SLR thematic analysis.

support systems, which indirectly support the adoption of AI technology.

Digital leadership also influences teachers' ability to integrate AI through professional development. A'mar and Eleyan (2022) argued that principals' performance in systemic improvement and cultural development is positively correlated with teachers' ability to integrate technology. Pietsch and Mah (2024) emphasized that principals' "digital thinking," such as empathy and agility, helps build a future-oriented technological vision. These leadership behaviors strengthen teachers' technology acceptance and practical application.

From a UTAUT perspective, leaders can drive technology adoption by influencing performance expectations and fostering enabling conditions. Molefi et al. (2024) noted that by raising performance expectations and creating favorable conditions, leaders enhance teachers' confidence and attitudes in integrating AI, strengthening their technology adoption behaviors, and acting as a key means of promoting AI use among teachers.

However, the influence of digital leadership on AI integration is not always relevant as noted by Atuahene and XuSheng (2024). According to their study, principals should implement more focused interventions since, while leadership behaviors may encourage the adoption of e-textbooks, they do not yet have a major direct influence on sophisticated technology like artificial intelligence. To increase the efficacy of their interventions, principals should modify their leadership techniques according to the situation.

In developing countries, digital leadership demonstrates even greater strategic significance. Asante and Novak (2024) argued that the presence of digital leadership and trust is a necessary condition for predicting teachers' use of digital educational resources. Cui and Hamid (2024) further noted that leadership support can enhance teacher capacity, promote evidence-based teaching, and improve student outcomes. This demonstrates that digital leadership not only influences teacher behavior but also contributes to teaching performance.

Effective digital leadership requires compliance with educational ethics. Kurkan and Çetin (2024) believed that trust is fundamental to leadership, and principals must guarantee that the use of AI technology adheres to essential values of educational justice and student growth while advocating for AI integration. Digital leadership must extend beyond mere technology implementation to have a focus on value orientation.

In conclusion, the digital leadership of principals affects teachers' capacity to incorporate AI in a variety of ways, such as professional development, ethical direction, organizational support, and cultural growth. Teachers' self-efficacy, motivation, and integration practices may be improved by the combined effects of transformational and digital leadership. This thorough approach highlights the crucial role that digital leadership plays in propelling the change of educational technology.

8.2 Question 2: What leadership practices are most effective in enhancing teachers' AI-related skills?

In the context of the fast advancement of AI, principals, as leaders of digital transformation in educational institutions, profoundly influence the development of teachers' AI competencies via their targeted leadership practices. According to the UTAUT model, Molefi et al. (2024) revealed that administrators may significantly increase

instructors' propensity to use AI technology by offering resource support, enhancing training methods, and delivering continuous help. This illustrates that organizational support and environmental influence are essential foundations for promoting teachers' technical development. The efficacy of technology integration relies not only on the availability of tools but also on the nurturing culture cultivated by leaders.

Halomoan et al. (2024) emphasized that in vocational education, principals' control over curriculum reform and resource allocation significantly promoted the effectiveness of AI curriculum implementation. Teachers' AI teaching abilities were enhanced by access to training and professional development opportunities. Leaders' roles were no longer limited to management, but rather became enablers of teacher development. This practical support provided a realistic foundation for educational reform.

Kafa (2025) further suggested that leaders themselves should receive AI-related training to ensure they can flexibly apply AI technology in teaching and management. Leadership practices should include establishing professional learning communities, continuous feedback mechanisms, and resource linkage systems to form a diverse support network. Leaders with AI literacy are more likely to achieve the win-win goal of system transformation and teacher capacity building.

The professional development of educators is closely linked to leadership practices. Cui and Hamid (2024) contended that leaders who provide training opportunities to teachers significantly enhance their capacity to teach and execute data-driven curriculum design. A learning-centered leadership style enhances instructors' self-efficacy, therefore augmenting their ability to integrate AI skills (Chan et al., 2024). This underscores the need for learning-oriented leadership in empowering teachers.

According to Pietsch and Mah (2024), digital leadership and transformation leadership have synergistic benefits. They stress that these two types of leadership are complementary strategies rather than replacements. According to Antonopoulou et al. (2025), technological adaptation, collaborative culture, and teacher motivation are all greatly aided by transformational leadership.

In summary, effective leadership practices require a fusion of strategic planning, emotional support, and professional development, with teacher-centeredness, shared goals, and strong support as core characteristics. Leaders not only provide organizational support but also guide teachers through vision, trust, and a learning community to address the challenges of AI transformation. This comprehensive leadership model is one of the most effective approaches to contemporary education reform.

8.3 Question 3: What barriers and facilitators exist in leadership-driven AI integration in schools?

While effectively integrating artificial intelligence (AI) into school environments holds enormous potential, it faces numerous challenges in practice. Current research suggests that AI integration is not only constrained by technological limitations but also deeply influenced by organizational support, psychological support, and school leadership (see Figure 4).

Principals' digital leadership is both a motivator and a challenge in the AI integration process. According to Atuahene and XuSheng (2024), instructors' fear about technology and a lack of adequate technical infrastructure are significant barriers, especially in rural regions. The trust that educators have in AI-powered instruction is weakened by these two technological and psychological constraints. Hoang (2025) and Atuahene and XuSheng (2024) also reported that instructors' reluctance to use AI often results from their faith in conventional teaching techniques, their worries about losing control over their lessons, or their skepticism about the technology's dependability.

The education system itself faces structural obstacles. Kafa (2025) and Kilcoyne (2024) noted that leaders in centralized systems often face time constraints, systemic limitations, and a lack of training support. Resource constraints in small schools and widely varying community conditions further weaken the foundation for digital transformation. A'mar and Eleyan (2022) and Alenezi and Alfaleh (2024) also found that a lack of ICT training for principals and teachers, unclear resources, and limited training opportunities indicate a lack of systematic support from school management in promoting AI integration.
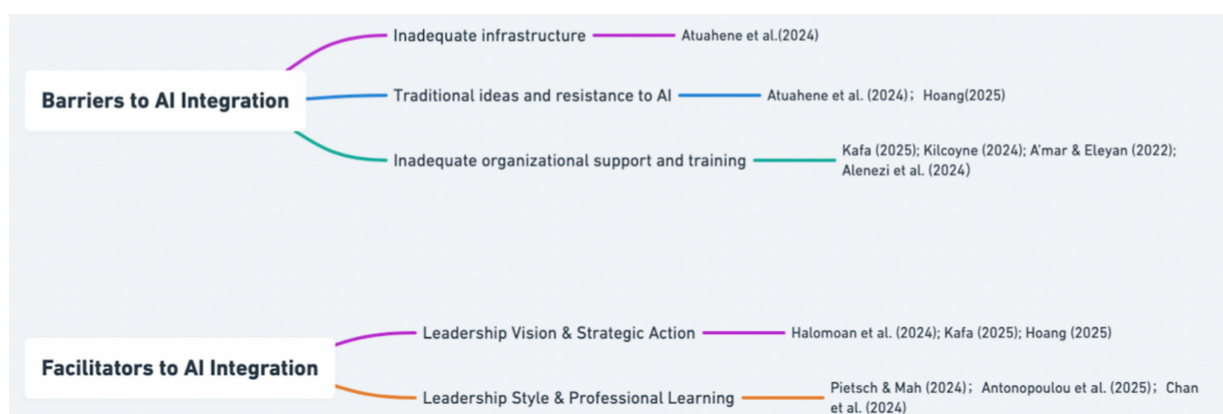

FIGURE 4
Barriers and facilitators in AI integration in education.

Despite numerous obstacles, research has revealed several contributing factors. First, resource investment and leadership vision are key to overcoming difficulties. Halomoan et al. (2024) identified that even in vocational schools with limited resources, if principals focus on curriculum innovation, AI integration can still achieve significant results. Kafa (2025) reported that many leaders have gradually recognized the potential of AI in supporting school management and improving teaching. Hoang (2025) further added that successful AI integration requires combining individual differences and development stages to establish a tiered support system. Provide dual support for infrastructure and leadership capacity building.

Secondly, the complementary nature of dual leadership styles has attracted considerable attention. Pietsch and Mah (2024) proposed that combining transformational and digital leadership can effectively enhance teacher adoption and improve integration outcomes. Antonopoulou et al. (2025) emphasized that insufficient teacher digital competence needs to be addressed through incentives and continuous professional development. Chan et al. (2024) also found that professional learning mechanisms mediate the relationship between leadership and teacher effectiveness, strengthening the actual impact of leadership practices on AI integration.

In summary, AI integration is a complex systems project, constrained by multiple factors, including resources, organizational support, and psychological factors. Principals' digital leadership plays a bridging and catalytic role in identifying obstacles, building support mechanisms, and stimulating teacher motivation. Through leadership strategies and teacher development mechanisms, the education system, driven by leadership, has the potential to achieve deep AI integration and educational innovation.

9 Discussion

This study reveals that principals' digital leadership not only influences teachers' AI integration capabilities through resource allocation but also plays a profound role in cultural construction and trust mechanisms. The discussion in this section is divided into five themes, as shown in Figure 5. In line with the UTAUT model, performance expectations and enabling conditions are key predictors of teachers' AI adoption, which are achieved through the training and infrastructure provided by leaders (Molefi et al., 2024). Antonopoulou et al. (2025) and A'mar and Eleyan (2022) further proposed that leadership style, especially transformational traits, plays a significant role in motivating teachers to actively integrate digital technologies, reinforcing the role of cultural and psychological support in technology adoption. Furthermore, Kurkan and Çetin (2024) emphasized that leaders must adhere to the boundaries of educational ethics and prevent the misuse of AI technology to achieve the value goals of educational equity and responsibility. Additionally, educators need to develop a sense of ethical use of technology (Yasin et al., 2024).

The research findings further identified several effective leadership practices. First, empirical research emphasizes that ongoing technical training and the development of teacher learning communities provide crucial support for improving teachers' AI skills (Halomoan et al., 2024; Kafa, 2025). Furthermore, the integration of principals' technological literacy and an ambidextrous leadership style has been

shown to enhance the effectiveness of AI implementation (Pietsch and Mah, 2024). These practices not only focus on organizational and institutional aspects but also foster a positive ecosystem for teacher growth through emotional motivation and professional development. This "teacher-centered, goal-aligned" leadership model represents a paradigm shift in leadership in the digital age and provides a solid humanistic foundation for AI integration.

Despite the promise of AI in education, its successful integration faces numerous barriers, including inadequate infrastructure, weak leadership, policy restrictions, and cultural resistance (Atuahene and XuSheng, 2024; Hoang, 2025; Kafa, 2025). The pervasive absence of structured training for principals in underdeveloped countries intensifies integration difficulties (A'mar and Eleyan, 2022). This reinforces the conclusion that leaders encounter the problem of delivering a clear vision, comprehensive plan, and foresight to their staff (Morgan and Papadonikolaki, 2021). Consequently, leaders must possess the ability to motivate, inspire, and cultivate a sense of vision and purpose.

In response to these challenges, research has identified three key factors that provide empirical support for achieving AI integration. First, curriculum resources provide the foundation for breaking the bottleneck of AI-driven education (Halomoan et al., 2024). Second, the synergy of transformational and digital leadership can promote the integration of AI in schools (Pietsch and Mah, 2024). And Third, teacher professional learning mechanisms serve as a bridge, strengthening the positive linkage between leadership behavior and teacher self-efficacy (Chan et al., 2024). Principals should coordinate efforts in resource support, leadership practices, and teacher development to achieve sustainable development of AI integration.

10 Significance of SLR

This study reveals the critical role of principals in promoting the integration of artificial intelligence (AI) in education, emphasizing that their digital leadership not only influences teachers' technology adoption but also plays a core guiding role in institutional development, cultural cultivation, and professional development. Based on a systematic review of recent empirical research, as shown in Figure 6, this study has the following four important implications.

Initially, the digital leadership of principals has shown a pivotal role in facilitating AI-driven educational transformation. Its effectiveness is not only reflected in providing technical resources and administrative structure, but more importantly, it promotes the professional development of teachers, cultivates a good cultural environment, and leads the vision of technological integration. Halomoan et al. (2024) asserted that strategic assistance from school leaders may significantly enhance educational achievements. According to Antonopoulou et al. (2025), transformational leadership and digital leadership could work together; however, Chan et al. (2024) highlighted the mediating function of teacher professional development. Administrators can enhance teachers' ability to adapt to AI by fostering a culture of learning, allocating resources as efficiently as possible, and creating a unified vision.

Secondly, a principal's own AI literacy, awareness of management innovation, and understanding of teacher culture and development stages also constitute crucial components of effective leadership practices. Kafa (2025) stated that principals should not only be resource allocators but also transition to being co-learners, placing
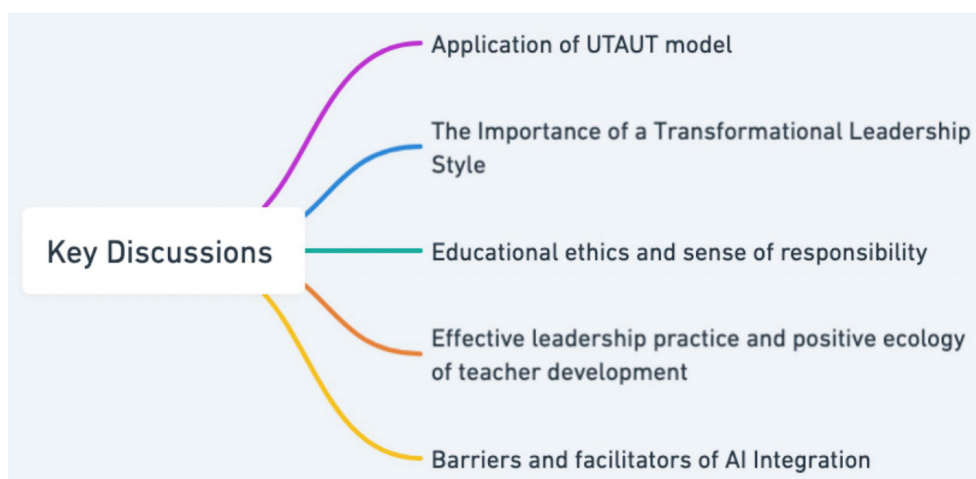
FIGURE 5
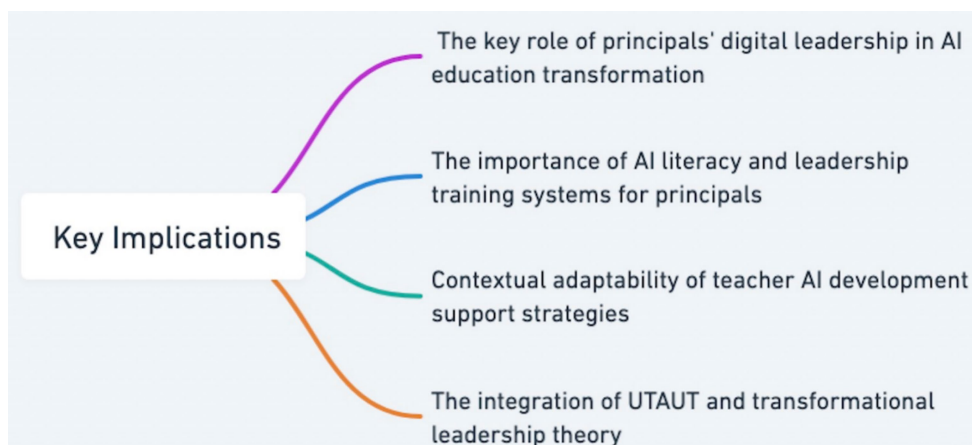Key discussions for AI integration.

FIGURE 6
Key implications for AI integration.

higher demands on principal training programs. Therefore, policymakers should prioritize the development of a principal leadership training system focused on AI literacy and collaborative culture, and increase infrastructure support for low-resource schools in terms of resource allocation.

Third, support for teachers' AI skills development should be tailored to local conditions and individual needs. As Hoang (2025) argued, differentiated professional development strategies and technical support systems should be developed based on teachers' developmental stages and cultural backgrounds. School administrators should move beyond traditional technical operational training and adopt a comprehensive support strategy that prioritizes teamwork, teacher support, and the digital campus.

Fourth, at the theoretical level, the study integrates the UTAUT model of technology acceptance and transformational leadership theory. Drawing on the structural elements of technology acceptance (e.g., performance expectations and facilitating conditions) and the underlying mechanisms of

leadership behavior (e.g., idealized influence, intellectual stimulation), this study provides a theoretical perspective for the integration of educational leadership and artificial intelligence. The study indicates that leadership factors not only influence technology adoption by enhancing teachers' perceived ease of use and usefulness of AI but also play a structural role in organizational trust, efficacy beliefs, and cultural atmosphere. The interactive integration of transformational leadership and UTAUT also reveals the complex dynamics inherent in educational systems, providing a basis for the construction of a systematic theory.

11 Limitations

While this study possesses theoretical and practical value, it is limited in terms of timeframe, language coverage, empirical depth, and theoretical perspective. Future research could explore these limitations.

First, the limited timeframe may have affected the historical depth of the conclusions and the integrity of the theoretical foundation. While focusing on empirical research from the past 5 years helps capture recent trends, it may have missed earlier, foundational research on educational leadership or AI integration, such as the development of digital leadership theory.

Second, English-language literature serves as the foundation for the study. Because of this, it is challenging to represent the unique characteristics and variations of principals' digital leadership approaches in non-English environments. To improve the findings' cross-cultural universality, future studies should expand their use of multilingual database searches.

Third, although this study selected empirical literature, it still faces the problem of insufficient empirical depth. Some of the included studies are mainly based on questionnaire data or cross-sectional surveys, lacking long-term follow-up and in-depth interviews, making it difficult to fully reveal the dynamic mechanism of leadership behavior in the development of teachers' AI capabilities.

Finally, research still faces a tension between theory and practice. Although this study has constructed a theoretical framework that integrates UTAUT and transformational leadership, the causal mechanism between leadership style and technology adoption has not been fully explained in the existing literature. The intricate dynamics of educational leadership can no longer be completely revealed by a single theory, especially in light of the ongoing advancements in artificial intelligence technology.

The relationship between managerial behavior and teachers' adoption of AI should be better understood by future research that integrates various theoretical perspectives, including situational leadership, distributed leadership, and organizational learning, and further examines how particular leadership practices enhance teachers' AI capabilities. Expanding the body of knowledge and improving the theoretical application of research across various educational contexts may also be achieved by supporting longitudinal study designs, including findings from non-English research, and incorporating prior literature.

12 Conclusion

This study's systematic literature review highlights the critical role of principals' digital leadership in enabling teachers to effectively integrate AI. By applying transformational leadership strategies and the principles of the UTAUT model, leaders can inspire teachers to actively adopt technology and provide a supportive environment for educational AI integration. This study systematically reviewed 14 empirical studies between 2021 and 2025 on principals' digital leadership and teachers' AI integration capabilities, highlighting the crucial role of digital leadership in promoting educational AI integration. The study found that principals significantly enhanced teachers' willingness to adopt and integrate AI technologies through multi-dimensional mechanisms such as resource allocation, cultural development, and professional support. A comprehensive analysis of the results reveals three key conclusions: First, principals' digital leadership effectively enhances teachers' AI integration capabilities through resource support and professional development; second, a collaborative dual leadership style, learning-centered support strategies, and professional learning communities are key practical approaches; and third, while challenges in AI integration, such as insufficient technical resources and teacher resistance, can be overcome through strategic investment, leadership collaboration,

and continuous professional development. This study integrates UTAUT with transformational leadership theory to construct an analytical framework for understanding educational technology adoption, providing a theoretical foundation for subsequent exploration of the impact of institutional innovation, educator preparedness, and leadership style on teaching effectiveness. The study also calls for attention to systemic reform and leadership capacity building to fully leverage the potential of artificial intelligence in teaching improvement.

Data availability statement

Author contributions

MZ: Conceptualization, Writing – original draft. KC: Supervision, Writing – review & editing, Conceptualization. ZA: Supervision, Writing – review & editing.

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. During the writing process, the author used generative artificial intelligence to assist in language polishing and improving the clarity of expression. All academic content, structural design, research analysis, and conclusions of the article were independently completed and confirmed by the author himself.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

References

Aghaziarati, A., Nejatifar, S., and Abedi, A. (2023). Artificial intelligence in education: investigating teacher attitudes. *AI Tech Behav. Soc. Sci.* 1, 35–42. doi: 10.61838/kman.aitech.1.1.6

AlAjmi, M. K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *Int. J. Educ. Res.* 112:101928. doi: 10.1016/j.ijer.2022.101928

Alenezi, N., and Alfaleh, M. (2024). Enhancing digital citizenship education in Saudi Arabian elementary schools: designing effective activities for curriculum integration. *Front. Educ.* 9:1494487. doi: 10.3389/feduc.2024.1494487

Alzoraiki, M., Ahmad, A. R., Ateeq, A. A., Naji, G. M. A., Almaamari, Q., and Beshr, B. A. H. (2023). Impact of teachers' commitment to the relationship between transformational leadership and sustainable teaching performance. *Sustainability* 15:4620. doi: 10.3390/su15054620

A'mar, F., and Eleyan, D. (2022). Effect of principal's technology leadership on teacher's technology integration. *Int. J. Instr.* 15, 781–798. doi: 10.29333/iji.2022.15145a

Antonopoulou, H., Matzavinou, P., Giannoukou, I., and Halkiopoulos, C. (2025). Teachers' digital leadership and competencies in primary education: a cross-sectional behavioral study. *Educ. Sci.* 15:215. doi: 10.3390/educsci15020215

Asante, K., and Novak, P. (2024). When the push and pull factors in digital educational resources backfire: the role of digital leader in digital educational resources usage. *Educ. Inf. Technol.* 29, 6553–6578. doi: 10.1007/s10639-023-12095-8

Atuahene, S. A., and XuSheng, Q. (2024). Overcoming e-learning hurdles: strategies for enhancing STEM education in Africa through digital innovation. *Stud. High. Educ.*, 1–18. doi: 10.1080/03075079.2024.2413866

Bass, B. M. (1990). From transactional to transformational leadership: learning to share the vision. *Organ. Dyn.* 18, 19–31. doi: 10.1016/0090-2616(90)90061-S

Bass, B. M. (1985). Leadership and performance beyond expectations, New York: Free press.

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* 3, 77–101. doi: 10.1191/1478088706qp063oa

Chan, P. Y., Cheah, P. K., and Choong, Y. O. (2024). Digital era learner-centered leadership and teachers' efficacy: the mediating role of teachers' professional learning. *J. Prof. Cap. Community.* doi: 10.1108/JPCC-06-2024-0090

Cheng, E. C. K., and Wang, T. (2023). Leading digital transformation and eliminating barriers for teachers to incorporate artificial intelligence in basic education in Hong Kong. *Comput. Educ. Artif. Intell.* 5:100171. doi: 10.1016/j.caeai.2023.100171

Cui, Z., and Hamid, A. H. A. (2024). The impact of digital leadership in enhancing teaching capacity through data-driven strategies among faculty in education programs in China. *Eurasian J. Educ. Res.* 114.

Fullan, M., Azorín, C., Harris, A., and Jones, M. (2024). Artificial intelligence and school leadership: challenges, opportunities and implications. *Sch. Leadersh. Manag.* 44, 339–346. doi: 10.1080/13632434.2023.2246856

Gligorea, I., Cioca, M., Oancea, R., Gorski, A. T., Gorski, H., and Tudorache, P. (2023). Adaptive learning using artificial intelligence in e-learning: a literature review. *Educ. Sci.* 13:1216. doi: 10.3390/educsci13121216

Halomoan, H., Hakiki, M., Ramadhan, M. A., Hidayah, Y., Fakhri, J., Aljamaliah, S. N. M., et al. (2024). Integrating principal leadership and teacher roles with AI-based 'Merdeka' curriculum innovation: the quantitative research. *TEM J.* 13:3397. doi: 10.18421/TEM134-73

Hamid, N. A., Kamaruzaman, F. M., and Rasul, M. S. (2024). Concept of circular economy in technical and vocational education: a systematic literature review. *Int. J. Eval. Res. Educ.* 13:2251. doi: 10.11591/ijere.v13i4.28125

Hamzah, N. H., Nasir, M. K. M., and Wahab, J. A. (2021). The effects of principals' digital leadership on teachers' digital teaching during the COVID-19 pandemic in Malaysia. *J. Educ. E-Learn. Res.* 8, 216–221. doi: 10.20448/journal.509.2021.82.216.221

Harry, A. (2023). Role of AI in education. *Interdicip. J. Humm.* 2, 260–268. doi: 10.58631/injurity.v2i3.52

Hoang, N. H. (2025). E-leadership in the AI era: exploring Vietnamese EFL teachers' digital leadership development in AI integration. *Educ. Inf. Technol.* 30, 16895–16928. doi: 10.1007/s10639-025-13451-6

Hou, M., Ahmad, J. B., and Zhao, Y. (2024). Integrating transformational leadership with artificial intelligence: driving a new future for Chinese K-12 education. *Int. J. Educ. Organ. Leadersh.* 31, 123–144. doi: 10.18848/2329-1656/CGP/v31i01/123-144

Kafa, A. (2025). Exploring integration aspects of school leadership in the context of digitalization and artificial intelligence. *Int. J. Educ. Manag.* 39, 98–115. doi: 10.1108/IJEM-11-2024-0703

Karakose, T., Polat, H., and Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic. *Sustainability* 13:13448. doi: 10.3390/su132313448

Kilcoyne, A. (2024). Navigating through disruption: how are school principals leading digital learning in secondary schools in Ireland. *Comput. Sch.* 1-19, 1–19. doi: 10.1080/07380569.2024.2374262

Kurkan, G., and Çetin, M. (2024). The perceptions of educational administrators towards digital leadership in the age of artificial intelligence: a qualitative study. *Int. J. Contemp. Educ. Res.* 11, 425–439. doi: 10.52380/ijcer.2024.11.3.602

Leithwood, K., and Jantzi, D. (1999). Transformational school leadership effects: a replication. *Sch. Eff. Sch. Improv.* 10, 451–479. doi: 10.1076/sesi.10.4.451.3495

Li, K., Rollins, J., and Yan, E. (2018). Web of science use in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. *Scientometrics 115*, 1–20. doi: 10.1007/s11192-017-2622-5

Lin, W., Yin, H., and Liu, Z. (2022). The roles of transformational leadership and growth mindset in teacher professional development: the mediation of teacher self-efficacy. *Sustainability* 14:6489. doi: 10.3390/su14116489

Mehdaoui, A. (2024). Unveiling barriers and challenges of AI technology integration in education: assessing teachers' perceptions, readiness and anticipated resistance. *Fut. Educ.* 4, 95–108. doi: 10.57125/fed.2024.12.25.06

Mehmood, S. (2023). Exploring digital leadership, technology integration, and teacher task performance in higher education institutions: a moderated-mediation study. *J. Digitovation Inf. Syst.* 3, 141–155. doi: 10.54433/JDIIS.2023100026

Molefi, R. R., Ayanwale, M. A., Kurata, L., and Chere-Masopha, J. (2024). Do in-service teachers accept artificial intelligence-driven technology? The mediating role of school support and resources. *Comput. Educ. Open* 6:100191. doi: 10.1016/j.caeo.2024.100191

Morgan, B., and Papadonikolaki, E. (2021). Digital leadership for the built environment industry 4.0for the built environment: methodologies, technologies and skills. Cham: Springer International Publishing, 591–608.

Muslim, A. Q., and Setyono, L. (2024). Exploring the nexus of digital leadership and digital literacy on higher education performance: the role of digital innovation. *Eur. J. Educ. Res.* 13, 207–218. doi: 10.12973/eu-jer.13.1.207

Omidvar, S., and Meihami, H. (2025). Exploring the "what" and "how" of opportunities and challenges of AI in EFL teacher education. *Comput. Educ. Artif. Intell.* 9:100443. doi: 10.1016/j.caeai.2025.100443

Orunbon, N. O., Ibikunle, G. A., and Badmus, A. A. (2023). Principals' digital transformational leadership, teachers' organisational commitment and job satisfaction during COVID-19 in Lagos state Education District V, Nigeria. *Int. J. Humanit. Technol. Civiliz.*, 8, 68–73. doi: 10.15282/ijhtc.v8i1.9424

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 372:n71. doi: 10.1136/bmj.n71

Pietsch, M., and Mah, D. K. (2024). Leading the AI transformation in schools: it starts with a digital mindset. *Educ. Technol. Res. Dev.* 73, 1043–1069. doi: 10.1007/s11423-024-10439-w

Purnama, S., Ulfah, M., Ramadani, L., Rahmatullah, B., and Ahmad, I. F. (2022). Digital storytelling trends in early childhood education in Indonesia: a systematic literature review. *JPUD* 16, 17–31. doi: 10.21009/JPUD.161.02

Ridho, M. R., Lesmana, I., Safitri, H. D. A., Meirani, R. K., and Prestiadi, D. (2023). Digital leadership in the scope of education. In International conference on educational management and technology (ICEMT 2022), Advances in social science, education and humanities research (ASSEHR 727). pp. 52–61)

Rohman, A. (2024). Integrating local cultural values into early childhood education to promote character building. *IJLTER ORG* 23, 84–101. doi: 10.26803/ijlter.23.7.5

Santamaria-Granados, L., Mendoza-Moreno, J. F., and Ramirez-Gonzalez, G. (2020). Tourist recommender systems based on emotion recognition—a scientometric review. *Future Internet* 13:2. doi: 10.3390/fi13010002

Santhanasamy, C., and Yunus, M. M. (2022). A systematic review of flipped learning approach in improving speaking skills. *Eur. J. Educ. Res.* 11, 127–139. doi: 10.12973/eu-jer.11.1.127

Shal, T., Ghamrawi, N., and Naccache, H. (2024). Leadership styles and AI acceptance in academic libraries in higher education. *J. Acad. Librariansh.* 50:102849. doi: 10.1016/j.acalib.2024.102849

Sohrabi, C., Franchi, T., Mathew, G., Kerwan, A., Nicola, M., Griffin, M., et al. (2021). PRISMA 2020 statement: what's new and the importance of reporting guidelines. *Int. J. Surg.* 88:105918. doi: 10.1016/j.ijsu.2021.105918

Tian, M., Deng, P., Zhang, Y., and Salmador, M. P. (2018). How does culture influence innovation? A systematic literature review. *Manag. Decis.* 56, 1088–1107. doi: 10.1108/MD-05-2017-0462

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Q.* 27, 425–478. doi: 10.2307/30036540

Yasin, I. R., Abdul Razak, A. Z., Abdullah, Z., Mustafa, W. A., and Risdianto, E. (2024). E-Learning application and teacher autonomy: A comprehensive review. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 57, 116–133.