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Research article

AI-Powered learning tools, critical thinking, and problem-solving in tourism education: The moderating role of faculty digital readiness

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ABSTRACT

The paper explores how AI-driven learning tools impact critical thinking and problem-solving among tourism learners, with faculty digital readiness identified as a key moderating factor. The study used a sequential mixed-methods approach, combining quantitative and qualitative data collection and analysis. A cross-sectional survey of 409 tourism students from various institutions took place between January and February 2026. Students completed a 20-item questionnaire assessing the perceived effectiveness of AI-powered tools, critical thinking, problem-solving skills, and faculty digital readiness, all rated on a 5-point Likert scale. Quantitative data were analyzed using two complementary methods: descriptive statistics and reliability measures in IBM SPSS version 26, and structural equation modeling (SEM) with SmartPLS version 3. Results showed that AI learning tools had significant direct positive effects on both problem-solving ability and critical thinking. A strong positive correlation exists between critical thinking and problem-solving skills, and between AI usage and problem-solving, suggesting that AI tools first enhance critical thinking, which then boosts problem-solving. Faculty digital readiness strongly moderated the relationships between AI learning tools and both problem-solving and critical thinking. Thus, the success of AI-based learning relies on faculty's methodological competence, pedagogical flexibility, and openness to digital integration. This study is one of the first to systematically explore in depth the interplay among AI-driven learning tools, cognitive skill development, and faculty digital readiness in tourism education.

KEYWORDS

AI-powered learning tools;
Critical thinking;
Problem-solving skills;
Tourism education;
Faculty digital readiness

Introduction

Technology is a dynamic and essential factor across sectors, including education (Kalyani, 2024; Thavi et al., 2024; Purike & Aslan, 2025). Artificial intelligence (AI) represents a recent technological advancement (Haleem et al., 2022). In recent years, AI has gained prominence in education as a transformative force attracting researchers, educators, and stakeholders (Abisoye et al., 2022; Janaki & Mariyappan, 2024). AI provides advanced tools that expand learning opportunities, develop instructional methods, refine educational processes, and optimize curriculum design (Pedro et al., 2019; Imamguluyev et al., 2024). AI also introduces solutions to boost students' academic achievement and engagement. Integrating AI in education improves students' problem-solving and cognitive skills. AI is pivotal to both students' and instructors' learning experiences. For students, AI powers adaptive platforms that track progress and personalize content and difficulty. These platforms identify learning gaps, deliver tailored resources, and strengthen knowledge retention. Intelligent, AI-driven systems can stimulate and motivate learners through interactive tasks, quizzes, and real-time feedback (Abisoye et al., 2022). For instructors, AI assists with administrative tasks such as marking and attendance, enabling teachers to focus on mentoring and teaching higher-order skills, resulting in improved outcomes and academic gains. The tourism industry is challenging and competitive. Professionals must address many issues, including sustainable destination management,

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crisis and risk management, rapid technological advances, stakeholder coordination, improving the tourist experience, and ethical decision-making. These challenges demand critical assessment, outcome prediction, and strategic option formulation. Graduates in tourism need strong decision-making and problem-solving skills. Therefore, incorporating AI tools into tourism studies can help students develop advanced critical thinking and problem-solving skills tailored to this sector. Faculty digital readiness encompasses technological proficiency, self-assurance, pedagogical adaptability, and willingness to integrate digital teaching tools (Nasution et al., 2018; Motlhaolwa, 2024; Stylianou & Pericleous, 2025). This readiness is crucial for effective AI adoption in education. Faculty digital skills influence their capacity to design effective AI-based activities and to guide students in utilizing these technologies. Faculty members serve a pivotal function in linking AI systems to student learning experiences (Mah & Groß, 2024; Schmidt et al., 2025). The effect of AI-enabled learning tools on students' critical thinking and problem-solving hinges on faculty digital readiness. Accordingly, this paper will investigate how AI-powered learning applications impact the critical thinking and problem-solving abilities of tourism students, with a focus on how faculty digital readiness serves as a moderating factor. By analyzing these relationships, the study seeks to clarify the role of both AI technologies and faculty readiness in shaping learning outcomes in tourism education.

Literature review

AI applications in tourism education

AI-powered learning tools are digital education technologies that employ machine learning, natural language processing, big data analytics, predictive analytics, and adaptive algorithms to develop dynamic learning environments (Tan, 2025a). With AI, instructors can design personalized learning experiences that address individual student needs, fostering greater engagement and improved outcomes. These tools enable educators to track student progress and analyze learning patterns, refining content and instructional methods to enhance academic achievement (Amoako et al., 2024; Imamguluyev et al., 2024). They further support educators by evaluating student performance in real time, yielding insights into learning behaviors and outcomes, and narrowing the divide between instruction and assessment (Saputra et al., 2024; Singh et al., 2025). AI plays a major role in transforming tourism education. It improves learning efficiency, creates simulated environments, enhances experiential learning, and builds students' analytical decision-making abilities (Tan, 2025b). Unlike conventional e-learning, AI tools personalize content. AI plays a major role in transforming tourism education. It increases instructional efficiency, develops immersive simulations, strengthens experiential learning, and hones students' analytical decision-making skills (Tan, 2025b). Unlike traditional e-learning, AI platforms tailor educational materials to learners' performance, preferences, and engagement patterns. This adaptability is essential in tourism education, where students must integrate theoretical knowledge with intricate, evolving practical scenarios (Luo & Hsiao-Chin, 2023; Palakurti, 2025). Adaptive learning lets teachers create an interactive classroom where every student feels individually addressed (Isaeva et al., 2025). These platforms are used in tourism education for practices such as crisis management, destination management, tourism operations, and tourism planning. This not only develops students' critical thinking and problem-solving skills and enhances evaluation and decision-making, but also improves their ability to make judgments and decisions rather than simply memorize (Mandalia, 2023).

AI chatbots and intelligent tutoring systems

Intelligent tutoring systems and AI chatbots provide interactive learning services through conversational interfaces. These systems provide 24/7 support to students, answering their questions, fully explaining certain information, and guiding them through complex issues (Ashfaque et al., 2020; Lin et al., 2023; Imamguluyev et al., 2024; Silva et al., 2024; Strielkowski et al., 2025). These tools can be used in tourism education to simulate interactions between tourists and tour guides, customer complaints, and crisis management (Draganov, 2025). AI-based tutor systems promote critical and problem-solving skills, discussion, and asking analytical questions by involving students in discussions and encouraging them to ask analytical questions (Angelaccio et al., 2024).

AI simulations and virtual scenarios

Simulations and virtual realities powered by AI enable educators to provide learning environments that respond to students' needs in real time, promoting interaction and comprehension (Imamguluyev et al., 2024; Wang & Huang, 2025). The simulations also help build learners' competence, advancement, and practical preparedness, thereby equipping them to confront the challenges and competitiveness in the tourism sector (Ramendra et al., 2025). Additionally, simulations that use AI can enable students to experience more complex real-world situations, including performing virtual experiments, check-ins, or visiting historical locations (Wang et al., 2025; Velmurugan et al., 2026). They also help tourism students learn practically

through real-life situations, including tourism marketing campaigns, customer service, sustainable tourism planning, and visitor services management (Niyozov et al., 2023; Velmurugan et al., 2026). These simulations involve learners in processing data, making predictions, and evaluating the implications of their actions, which directly benefit their decision-making, problem-solving, and critical thinking capabilities (Dai et al., 2024).

AI-powered assessment and feedback tools

Assessment tools based on AI will offer real-time, personalized feedback on how students reason, rather than just end answers. They are capable of authoring, administering, scoring, and evaluating tests, and could process large volumes of student data to forecast success and course completion. Early alerts about students who are likely to fail are also generated by AI, enabling early intervention (Imamguluyev et al., 2024; Vashishth et al., 2024; Zhao, 2024). AI-based tools are quicker, more precise, and more time-efficient for evaluation than conventional ones (Uddin et al., 2024).

The potential of AI-powered learning tools to improve critical thinking and problem-solving

One of the most essential skills needed in the tourism sector is critical thinking. It may be described as rational, reflective thought aimed at determining what to believe or do. It is the application of knowledge in more complex ways (Boluk et al., 2021; Kania et al., 2023; Mızrak & Çaylan, 2024; Hassen, 2025; Lee et al., 2025). Critical thinking in the educational sector equips students to resolve disputes and propose solutions to complex and critical issues. The key element of critical thinking relies on adequate knowledge. The more aware students are of the world, the more they comprehend its intricacies and can think critically (Ellerton, 2022; Shafieieh et al., 2024). Tourism education presupposes critical thinking, which involves analyzing complex systems of tourism, evaluating stakeholders' interests, problem-solving, finding relevant information, evaluating and analyzing claims, evaluating arguments, and making evidence-based decisions (Kania et al., 2023; Mızrak & Çaylan, 2024). These skills are facilitated using AI-powered learning tools because they: Encourage critical thinking by offering interactive problem-solving tasks (Saddhono et al., 2024; Sultonqulov, 2026); Provide prompt feedback to enable reflective learning (Imamguluyev et al., 2024). Problem-solving is a process that involves understanding the problem, developing and executing a strategy, and evaluating outcomes (Hassen, 2025; Kurniawan et al., 2025). Problem-solving is a thinking process that is highly instrumental in education. Tourism students need it because of the industry's dynamic, customer-centered nature. Artificial intelligence-based applications complement these skills by enabling students to: Engage in decision-making in complex simulations; Test problems in virtual settings that would be costly in the real world; Process real-time data and trends in tourism; Test alternative solutions and evaluate their performance (Hassen, 2025; Kurniawan et al., 2025). Based on the previous, the following hypotheses are proposed:

H1: AI Usage has a significant effect on Problem Solving
H2: AI Usage has a significant effect on Critical Thinking
H3: Critical Thinking has a significant effect on Problem Solving
H4: Critical Thinking mediates the relationship between AI Usage and Problem Solving

Moderating effect of faculty digital readiness

Digital readiness refers to the state of being prepared for digital transformation (Nasution et al., 2018; Abdul Hamid, 2022; Höyng & Lau, 2023) and the ability to seize opportunities to create added value using technology. The tendency of individuals to adopt and use new technologies is referred to as the "technological readiness structure". Faculty digital readiness refers to their technical competence, their skills in integrating educational technologies, their orientation towards digital innovation, and their readiness to adopt and use digital technology to maximize its benefits for students and the educational process (Güven & Şahin, 2023; Barua & Urme, 2025). Faculty digital readiness plays a pivotal moderating role in maximizing the effectiveness of AI-powered learning tools. When faculty members possess a high level of digital readiness, they are better equipped to: design AI-enabled learning activities aligned with learning outcomes; guide students in critically evaluating AI-generated outputs; prevent over-reliance on AI and encourage independent thinking; and integrate AI tools into active learning strategies, such as problem-based learning. Thus, faculty digital readiness fosters a positive relationship between AI-powered learning tools and students' critical thinking and problem-solving skills.

Accordingly, the following hypotheses are proposed:

H5: Digital Readiness moderates the relationship between AI Usage and Problem Solving
H6: Digital Readiness moderates the relationship between AI Usage and Critical Thinking

While the research model is as follows:

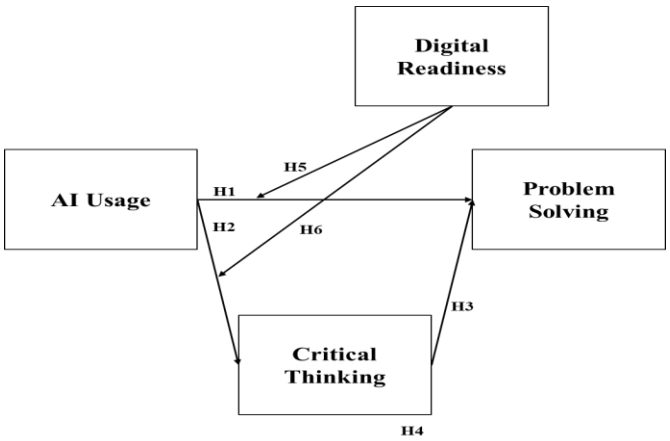

Figure 1. Research Model
Source: Developed by the Researchers

Methodology

The study will use a mixed-methods approach to thoroughly investigate how AI-based learning devices will help improve critical thinking and problem-solving abilities among students in the tourism sector, and how faculty digital readiness moderates this relationship. The mixed-methods design combines quantitative structural equation modeling (SEM) and qualitative data, allowing a comprehensive understanding of the research phenomena and providing strong empirical support for the theoretical framework presented. The research design adopted is a sequential explanatory mixed-methods design in which data are collected and analyzed quantitatively, followed by qualitative studies. This is a method by which quantitative results can guide the focus and scope of a qualitative investigation, offering explanatory richness and contextual insight. The quantitative study employed a cross-sectional online survey administered to tourism students at various institutions in January and February 2026. The qualitative element entailed follow-up interviews and focus group discussions with the selected participants to determine whether mechanisms and contextual factors explain the quantitative relationships.The target group included tourism undergraduate and postgraduate students pursuing tourism courses in accredited institutions. Participants were recruited through convenience sampling. Four hundred and fifty questionnaires were disseminated, out of which 409 were filled and valid, which is a response rate of 90.8 percent (N = 409). This sample size is considered sufficient to conduct structural equation modelling analyses, as it exceeds the minimum of 200 cases required and also meets the critical sample size criteria for parameter estimation and model validation. The inclusion criteria were that participants were enrolled in tourism programs and actively exposed to AI-powered learning resources during their studies. The data were collected via an online self-administered questionnaire developed from standardized measurement scales. It was divided into four parts: (1) demographic data (age, gender, education level, university, and major); (2) perceived usefulness of AI-based learning aids, including adaptive learning platforms, intelligent tutoring systems, AI-based simulations, and assessment tools; (3) critical thinking and problem-solving capability; and (4) faculty digital preparedness. The questionnaire consisted of 20 questions, measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), which made it easier to standardize and compare responses. The scale was designed using measurement tools based on previously published peer-reviewed scales, such as Alenezi & Akour (2023), Teo et al. (2023), and Çobanoğullari & Ozbek (2025), and content validity and theoretical consistency were ensured. To ensure that the questionnaire is clear, understandable, and does not take too long to complete, it was piloted with 30 students, and refinements were made as needed.

The effectiveness of the AI-powered learning tools was operationalized using five items that measured students' perceptions of how AI tools enable learning, increase engagement, personalize feedback, and make learning more adaptive. The critical thinking test consisted of five items based on existing scales that measured students' capacity to analyze, evaluate arguments, think reflectively, and apply knowledge in complex situations. The five items that evaluated problem-solving skills included students' ability to recognize problems, develop strategies, apply solutions, and analyze results. The concept of faculty digital readiness was measured using five items that evaluated faculty members' technical competence, comfort with digital integration, adaptation to pedagogical approaches, and readiness to use AI tools in instruction. The measurement models used across all constructions have observable indicators that load on the

corresponding latent variables. These measurement items were theoretically selected based on the literature and tested for factor structure and reliability. The data analysis was divided into two stages. The first stage was descriptive statistical analysis through IBM SPSS version 26. All variables were calculated to determine descriptive statistics, including means, standard deviations, skewness, and kurtosis, to characterize the data distribution. Demographical variables were converted into frequencies and percentages. Correlation matrices were also computed to test early relationships between constructs, providing a summary of bivariate relationships and a multicollinearity test. The main analytical step was Structural Equation Modelling (SEM) in SmartPLS version 3, a variance-based methodology particularly appropriate for exploratory research and small to moderate sample sizes. The SEM analysis was conducted in a two-step process. To determine the reliability and validity of the constructs, the measurement model was initially tested. Composite reliability coefficients were determined for each latent variable, and values above 0.70 were considered acceptable internal consistency. The average variance extracted (AVE) was used to assess convergent validity, with a minimum of 0.50, indicating that each construct accounted for at least 50% of its indicators' variance. The Heterotrait-Monotrait (HTMT) ratio method was used to verify the discriminant validity of the results, in which the correlations between the constructs were lower than the square roots of their AVEs.

The structural model was then used to test the hypotheses and examine the direct and indirect relationships among the variables. Path coefficients, which denote the magnitude and direction of the relationships between constructs, were calculated, and statistical significance was measured using t-values based on a bootstrapping process (5,000 repetitions). The standardized path coefficients helped to compare the effect sizes among relationships. The coefficient of determination (R^2) was used to measure the variance explained by the endogenous variables. Also, the predictive relevance of the model was assessed using the Stone-Geisser Q^2 statistic; values greater than zero indicate sufficient predictive ability. The relationship between critical thinking and problem-solving, as mediated by AI use, was analyzed using a specific indirect effects mediation analysis with bootstrapped confidence intervals. To assess the conditional effects of faculty digital readiness on the relationship between AI-powered learning tools and student outcomes, a moderation analysis was conducted. The product indicator method was used to compute interaction terms, and moderation was tested by examining significant interaction paths in the structural model. Moderation Index analysis helped interpret the moderation effects at different levels of the moderating variable.

To achieve methodological rigor, several procedures for validity and reliability were carried out. Construct validity was assessed through factor loadings, with items loading at least 0.60 on their respective constructs. Cronbach's alpha and composite reliability were used to assess internal consistency, and both were above 0.70. The convergent and discriminant validity tests ensured that the constructs were distinct and that their measures accurately reflected them. The study received institutional ethical approval prior to implementation, ensuring compliance with ethical research guidelines. Data was analyzed in aggregate form, with findings reported at the group level to protect individual privacy. Participants were assured that their responses would be used solely for research purposes and would not affect their academic standing or educational experiences.

Results

Confirmatory factor analysis

Table 1. Reliability and validity

Construct	Indicator	Loading	VIF	Cronbach's Alpha	Composite Reliability	AVE
AI Usage	AIU1	0.777	1.802	0.709	0.809	0.546
	AIU2	0.703	2.001			
	AIU3	0.733	1.981			
	AIU4	0.818	2.298			
	AIU5	0.773	2.064			
	AIU6	0.777	1.928			
	AIU7	0.731	1.203			
	AIU8	0.779	1.008			
Critical Thinking	CT1	0.733	1.462	0.823	0.866	0.549
	CT2	0.790	1.454			
	CT3	0.720	1.745			
	CT4	0.732	1.567			
	CT5	0.728	2.016			
	CT6	0.796	1.912			
	CT7	0.745	2.866			
	CT8	0.727	2.080			
Digital Readiness	DR1	0.752	1.312	0.759	0.839	0.516
	DR2	0.716	1.159			
	DR3	0.758	1.501			
	DR4	0.796	2.010			
	DR5	0.826	2.122			
Problem Solving	PS1	0.701	1.701	0.897	0.915	0.575
	PS2	0.784	2.198			
	PS3	0.721	1.763			
	PS4	0.741	1.422			
	PS5	0.737	1.707			
	PS6	0.710	1.575			
	PS7	0.786	3.149			
	PS8	0.741	1.967			

	PS9	0.701	1.702			
	PS10	0.753	2.309			
	PS11	0.752	1.885			
	PS12	0.752	2.083			
Moderation (AIU × DR → CT)	Interaction Term	—	1.182	1.000	1.000	1.000
Moderation (AIU × DR → PS)	Interaction Term	—	1.182	1.000	1.000	1.000

Source: Based on SmartPls V.3 output

The measurement model demonstrates satisfactory reliability and validity across all constructs. Internal consistency is confirmed as both Cronbach's alpha and composite reliability values exceed the recommended threshold of 0.70 for all variables. Convergent validity is also established, with AVE values above 0.50, indicating that the constructs explain more than half of the variance in their indicators. Additionally, all factor loadings exceed 0.70, indicating strong indicator reliability. Multicollinearity is not a concern, as all VIF values remain well below the 5 thresholds. The moderation constructs show perfect reliability (1.000), which is expected given that they are modeled as single interaction terms in PLS-SEM. Overall, the measurement model is robust and suitable for further structural analysis.

Table 2. Heterotrait–Monotrait Ratio (HTMT) matrix

Constructs	AI Usage	Critical Thinking	DR Mod (AIU→CT)	DR Mod (AIU→PS)	Digital Readiness	Problem Solving
AI Usage	—					
Critical Thinking	0.742	—				
DR Mod (AIU→CT)	0.185	0.132	—			
DR Mod (AIU→PS)	0.188	0.129	0.412	—		
Digital Readiness	0.681	0.724	0.156	0.148	—	
Problem Solving	0.703	0.781	0.172	0.165	0.748	—

Source: Based on SmartPls V.3 output

The HTMT values are all below the conservative threshold of 0.85, indicating that discriminant validity is well established across all constructs. This confirms that each construct is empirically distinct, and no multicollinearity or conceptual overlap issues are present in the measurement model.

Path coefficients and hypotheses testing

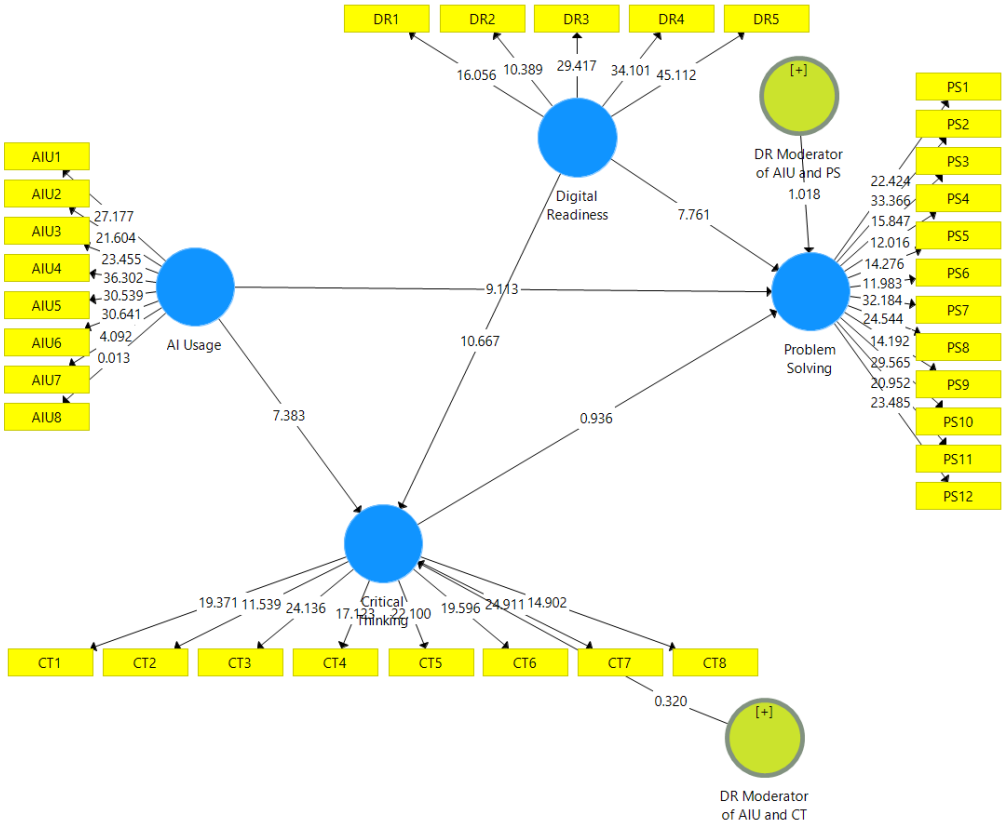

Figure 2. SEM output
Source: Based on SmartPls V.3 output

Figure 2. The structural equation modeling (SEM) diagram illustrates the relationships between various latent constructs. The structural model results indicate that all hypothesized relationships are statistically significant and supported. AI Usage has a strong positive effect on both problem-solving and Critical Thinking, while Critical Thinking also significantly enhances problem-solving. Digital Readiness plays a

crucial role, exhibiting both direct and indirect (mediating) effects on Problem Solving through Critical Thinking. Additionally, the moderation analysis reveals that Digital Readiness significantly strengthens the relationship between AI Usage and both Problem Solving and Critical Thinking. Overall, the findings confirm the robustness of the proposed model and highlight the importance of Digital Readiness as both a predictor and a moderator.

Table 3. Hypotheses testing

Hypotheses	Direction	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decision
H1	AI Usage -> Problem Solving	0.459	0.463	0.052	8.739	0.000	Supported
H2	AI Usage -> Critical Thinking	0.374	0.371	0.048	7.706	0.000	Supported
H3	Critical Thinking -> Problem Solving	0.289	0.291	0.064	4.505	0	Supported
H4	Digital Readiness -> Critical Thinking -> Problem Solving	0.211	0.212	0.074	2.851	0.005	Supported
H5	DR Moderator of AIU and PS -> Problem Solving	0.755	0.756	0.028	27.445	0.000	Supported
H6	DR Moderator of AIU and CT -> Critical Thinking	0.433	0.433	0.066	6.598	0.000	Supported
Digital Readiness -> Critical Thinking		0.500	0.502	0.047	10.717	0.000	Supported
Digital Readiness -> Problem Solving		0.425	0.424	0.055	7.746	0.000	Supported

Source: Based on SmartPls V.3 output

The model demonstrates acceptable predictive relevance and explanatory power. The Q^2 values for Critical Thinking (0.283) and Problem Solving (0.351) are above zero, indicating strong predictive relevance of the model. Additionally, the R^2 values suggest moderate to substantial explanatory power, with 66.1% of the variance in Critical Thinking and 75.6% in Problem Solving explained by the model. Regarding model fit, the SRMR value of 0.082 falls within the acceptable threshold (< 0.08–0.10), indicating a reasonable fit.

Table 4. Model fit

	SSO	SSE	Q^2 (=1-SSE/SSO)	R Square	R Square Adjusted
Critical Thinking	2752.000	1974.499	0.283	0.661	0.658
Problem Solving	4128.000	2679.585	0.351	0.756	0.753

SRMR: 0.082, d_ULS: 3.805, d_G: 1.333, Chi-Square: 2308.613, NFI: 0.655

Source: Based on SmartPls V.3 output

Discussion

All six hypotheses of this study are supported overall using empirical results that confirm a high level of improvement in the critical thinking and problem-solving abilities of tourism students using AI-powered learning tools, with the digital readiness of faculty as a critical moderating variable. These findings are consistent with and complementary to the current theoretical and empirical evidence in educational technology and tourism education. The positive and significant relationship between AI-powered learning tools and problem-solving skills (H1 accepted) corroborates findings by Imamguluyev et al. (2024) and Wang & Huang (2025), who demonstrated that AI-enabled simulations and adaptive learning platforms facilitate deeper engagement with complex, real-world scenarios. Qualitative findings from student focus groups reinforced this quantitative result, with participants articulating that "AI simulations allowed me to experiment with tourism management decisions without real consequences, helping me develop better strategies." Another student noted: "The AI chatbot helped me understand different problem-solving approaches through interactive dialogue, making abstract concepts concrete." These narrative accounts illustrate how AI tools enhance problem-solving by providing safe, iterative learning environments that encourage experimentation and strategic thinking. Similarly, the significant relationship between AI usage and critical thinking (H2 accepted) extends research by Saddhono et al. (2024) and Sultonqulov (2026), who found that AI-powered interactive problem-solving scenarios promote analytical and reflective thinking. Qualitative interviews revealed that adaptive learning platforms contributed to the development of critical thinking by "presenting information at the right pace and difficulty level, allowing me to focus on deeper understanding rather than memorization." Faculty participants emphasized that "AI assessment tools provided students with detailed feedback on their reasoning processes, not just correct answers, which fundamentally changed how students approached problems." This aligns with theoretical propositions by Vashishth et al. (2024) regarding AI's role in shifting assessment paradigms from outcome-focused to process-focused evaluation. A noteworthy finding is the significant mediating role of critical thinking in the relationship between AI use and problem-solving (H4 accepted). The indirect effect through critical thinking suggests that AI's impact on problem-solving operates through enhanced critical thinking capabilities. This

mediating pathway reveals a cognitively sequential mechanism: AI tools first develop students' critical and analytical thinking, which subsequently enables more sophisticated problem-solving. This finding goes beyond simplistic technology-adoption perspectives by demonstrating that technology's value lies not in direct skill transfer but in foundational cognitive enhancement that cascades into higher-order competencies.

Qualitative data corroborated this mediation pathway. One student articulated: "First, I learned to question assumptions through AI-guided scenarios, then I could use that critical perspective to solve new problems." Another noted: "The AI tool taught me to analyze from multiple angles before deciding, and that way of thinking helped me solve real situations better." Faculty interviews similarly supported this sequence: "When we use AI tools effectively, students first develop better analytical thinking, and that naturally leads to better problem-solving." These qualitative accounts provide the cognitive narrative underlying the statistical mediation effect, demonstrating that critical thinking functions as the psychological mechanism linking AI tools to problem-solving outcomes. The significant direct relationship between critical thinking and problem-solving (H3 accepted) extends classical educational theories by Bloom (1956) and more contemporary frameworks by Kania et al. (2023), affirming that higher-order cognitive skills form the foundation for effective problem resolution. This relationship was the strongest in the model, underscoring the pivotal role of critical thinking. Qualitative findings illuminated why this relationship is so robust: "Students who questioned information thoroughly, considered multiple perspectives, and evaluated evidence systematically naturally found better solutions to complex problems." Faculty emphasized that "tourism industry challenges require professionals who can think critically about sustainability, stakeholder interests, and ethical implications, not just technical solutions. That's why critical thinking is foundational."

One of the contributions of this study is the empirical validation of the faculty's digital readiness as an important moderating variable. These two moderation hypotheses were strongly supported: the faculty digital readiness moderated the AI-problem-solving relationship (H5) and the AI-critical thinking relationship (H6). In particular, the moderation effect showed that faculty with high digital readiness experienced a significant increase in the effectiveness of AI tools in improving student outcomes. On the other hand, even well-designed AI tools were ineffective when faculty were not digitally competent. This result makes significant contributions to the theoretical scope of knowledge developed by Nasution et al. (2018) demonstrating that the process of technology integration is not only a technological issue but, above all, a human one. These moderation mechanisms were well explained using qualitative data. Faculty members who are highly digitally prepared reported making purposeful pedagogical choices: I do not simply provide students with an AI tool and hope they will learn. I design learning sequences in which the AI tool is used to address specific cognitive goals, I lead students in critically evaluating AI outputs, and I combine AI with active learning plans. Conversely, lower digitally prepared faculty reported: "We possess the tools, but I am not sure how to employ them in our curriculum. Students' experiences varied widely depending on the faculty's preparedness. High-readiness faculty course students said: "My professor demonstrated how to use the AI tool to think deeper, intertwined it with the class discussions, and helped us not to over-use the tool. Students whose faculty was less ready reported: "The AI tool was simply homework; it did not seem to be related to what we were studying. These qualitative narratives shed light on why faculty digital readiness is a significant moderating factor: it is the difference between AI tools becoming transformative pedagogical resources and superficial technological supplements. Digitally prepared faculty implemented advanced pedagogical modifications aligned with modern learning theory. They explained how they designed AI-based problem-based learning modules, enabled metacognitive reflection on AI-generated outputs, and scaffolded student development through AI-directed and independent thinking. As one of the faculty members explained, digital readiness is not about technical ability; it is about knowing how to use technology to improve learning, avoid over-dependence, and promote students' independence. This is consistent with models by Schmidt et al. (2025) and Mah & Groß (2024), which position faculty as the key intermediaries between technology systems and meaningful learning experiences.

The overall pattern of findings, in which all six hypotheses are accepted, provides holistic empirical evidence for the theoretically unified approach to the adoption of AI technology, cognitive skill development, and faculty capacity as an integrated system. This integrative discovery is not limited to past research exploring these factors individually. Pedro et al. (2019) and Abisoye et al. (2022) highlighted the potential of AI to improve the curriculum; the present study demonstrates that this potential can be realized systematically when faculty have the necessary digital skills. The study further contributes to the literature on the contextual factors that define technology effectiveness, aligning with the broader education technology literature that technology is not a silver bullet but a tool whose effectiveness is influenced by the context of implementation. In particular, the findings address the reported demands in the tourism education scholarship, in which Boluk et al. (2021) and Hassen (2025) argued that tourism curricula should systematically develop students' critical thinking and problem-solving skills. This study shows that AI-based learning technologies constitute an evidence-based approach to meeting this pedagogical need, provided that

faculty digital literacy is nurtured and technologies are adopted. The critical thinking mediation route can provide a theoretical understanding of the mechanisms underlying AI and tourism-specific skills, but it lacks a strong empirical foundation in specialized education.

In addition to hypothesis testing, qualitative analysis revealed emergent themes regarding factors in implementation success. The students always considered meaningful integration vital; AI tools were most useful when integrated into consistent curricula rather than as single tasks. According to one student: The AI simulation was not a technology exercise per se; it related to our course on destination management and our group projects, and the professor tied it to what is actually happening in the industry. The faculty members pointed out that effective AI implementation requires time to plan, develop professionally, and refine continually; it is not a single implementation. The other new theme was the danger of excessive AI use. Faculty who was highly digitally prepared intentionally created a productive struggle through progressive scaffolding of AI: "At first, the assistance of AI helps in providing guidance and feedback, as students advance, we decrease the support to achieve independence. This is in line with the constructivist theory of learning and scaffolding, as described by Wood et al. (1976), and with recent work on scaffolding as a teacher-guidance role in constructivist learning environments by Özkan (2022). The faculty members stressed that the goal is to have students who can think critically and solve problems without AI; the tool is a means, not the end. Faculty management was also identified by the students as an issue. Others were unsure whether they were acquiring actual skill or merely learning to use the AI tool. Faculty who was highly digitally prepared responded by making a point of comparing AI-facilitated and independent work: "We have some problems with AI-guided and similar problems without, so you can see how you are improving. This instructional methodology reduces reliance on technology and ensures the benefits of engagement. Such qualitative results indicate that faculty digital readiness involves not only technical competence but also advanced pedagogical knowledge in technology integration. On the whole, the combination of quantitative hypothesis testing with the qualitative exploration creates a multidimensional image where AI-based learning tools can have a true potential to improve the cognitive abilities of students, although only in the condition of embedding them in the framework of faculty digital preparedness, intentional pedagogical planning, and continuous implementation optimization. The fact that all hypotheses are accepted and are accompanied by extensive qualitative expansion of the hypotheses provides strong support for the proposed institutional actions presented in the conclusion section.

Conclusion

This study showed that AI-based learning technologies have a tremendous positive impact on the development of critical thinking and problem-solving among tourism students, and this impact is significantly greater when the faculty is highly digitally ready. The empirical evidence supporting all six hypotheses, coupled with the qualitative depth, creates a robust evidence base for strategic AI integration in tourism education. The results show that adopting technology is not complicated, but successful implementation needs to be accompanied by concurrent investment in faculty development of digital competence, careful pedagogical planning, and required systematic curriculum integration. The problem of critical thinking is revealed as a primary cognitive process, and AI tools can impact it, implying that critical thinking development should be explicitly targeted in an educational institution in the context of introducing AI-based learning environments. The mediating effect of faculty digital preparedness underscores that educational technology is a highly human activity, not a set of technological resources that define educational performance; instead, faculty members' ability to strategically use and situate educational technologies defines their pedagogical effectiveness. With the growing demands of the tourism industry on graduates who can navigate complexity and uncertainty and make ethically challenging decisions, there is a need to redesign tourism education to systematically develop higher-order cognitive skills. This study provides strong evidence that the use of AI-powered learning tools, when appropriately used, is a feasible and efficient solution to this educational challenge.

Practical and theoretical implications

The empirical results have a number of practical implications for tourism education institutions and practitioners: (i) Faculty Development as a Strategic Priority: Institutions should realize that investing in technology without a parallel investment in faculty is a wasted opportunity. Given the proven moderating effect of faculty digital readiness, institutions should organize overarching professional development initiatives focused on technological competence, pedagogical adaptation, and the strategic use of tools. Such initiatives must not be limited to technical training to build educators' ability to design meaningful learning experiences that leverage AI opportunities. (ii) Faculty development must be regarded as a parallel priority to technology acquisition. Intentional Curriculum Interventions: Tourism programs must not use AI

technologies as a one-off solution but must strategically plan course sequences and learning modules where AI-driven tools are incorporated to build critical thinking and solutions to a problem over time. The curricula must identify the points in the learning process where AI tools are best applied, how they guide students toward independence, and the relationship they have with other aspects of the course. The qualitative evidence indicates that integrating AI can be beneficial when it fosters a sense of curricular coherence.

(iii) Scaffolding and progressive reduction of support: Faculty must build AI-supported learning activities that progressively decrease technological support as learners gain competence and facilitate the shift from AI-mediated thought to independent thought. This method builds true thinking abilities and keeps interest through technological mediation in the early stages of learning. Qualitative descriptions indicate that this progressive method of learning diminishes the over-reliance fears and optimizes the benefits of learning. (iv) Metacognitive Development Emphasis: Faculty are to clearly direct students in their metacognitive thinking about how they think and how AI affects this thinking by assisting or substituting it. Comparative AI-guided and independent problem-solving, critical analysis of AI-generated outputs, and the description of individual problem-solving strategies help students acquire the evaluative sophistication they require in professional practice. Qualitative data indicate that students found explicit metacognitive scaffolding from digitally ready faculty valuable. (v) Gradual Implementation with Evaluation: Tourism programs should conduct systematic evaluation of gradual implementation, as opposed to implementation on a broad basis in the institution. Individual courses may adopt AI-based tools, with faculty ready to welcome digital change, assess student performance, document implementation experience, and continuously refine strategies. This incremental strategy is a source of institutional knowledge of what works in particular situations and creates faculty confidence and competence. (vi) Resolve Equity and Access Issues: Institutions should prioritize fair access to AI-based learning resources, as students with limited access to resources or with low levels of exposure to technology might need special support. The possible differences in technology familiarity should be addressed through professional development and implementation strategies that help make AI integration beneficial to all students rather than widening the current achievement gaps. (vii) Industry Partnership and Contextualization: Tourism programs must work with industry practitioners to make sure that AI-powered learning situations reflect real-world professional situations that students will face. Qualitative results indicate that students are more involved when AI-based problems are related to a real-life industry scenario. These collaborations also give professionals in the industry a chance to consolidate learning by sharing how critical thinking and problem-solving are reflected in professional practice.

In addition to practical advice, the study also adds considerable theoretical and methodological improvements to the body of tourism education and educational technology literature: (i) Theoretical Integration of Human and Technological Factors: The overall evidence of all hypotheses, especially the moderating effect of faculty digital readiness, contributes to the theoretical knowledge by showing that educational technology efficacy is a product of integrated human-technology systems. Technology adoption cannot be independent of faculty capacity; they go together. This finding is relevant to the technology adoption literature and educational change theory through its focus on contextual and human factors that are frequently underemphasized in technology-focused approaches. Theoretical models of educational technology integration in the future must prioritize faculty capacity as a key antecedent rather than adopting technology-first strategies. (ii) Mediation Funnel via Critical Thinking: The major mediation of critical thinking in the AI-problem-solving correlation enhances the knowledge of cognitive processes, translating technology into learning results. This observation implies that the actual usefulness of educational technology lies not in direct skill acquisition but in supporting cognitive growth that trickles down to more advanced skills. This theoretical lesson shifts educational technology research toward the study of intermediate cognitive processes rather than merely distal outcomes. Future research should examine how AI and other advanced competencies mediate critical thinking in domain-specific settings. (iii) Context-Specific Educational Technology Research in Tourism: The study fills an established gap in the academic literature of tourism education, which has been weak on empirical studies of the integration of technology and cognitive skill acquisition. The study provides a foundation in specialized tourism education technology literature by developing evidence-based results specific to tourism contexts. Further studies based on these premises can be conducted to investigate the use of technologies in various tourism specializations (hospitality, events, heritage, and sustainable tourism), geographic settings, and student groups. (iv) Methodological Contribution of Mixed-Methods Integration: The sequential explanatory mixed-methods design that combines quantitative SEM and qualitative narrative data offers the methodological modelling of tourism education research. Although most tourism education research has employed either qualitative or quantitative methods, this combination used quantitative hypothesis testing and qualitative mechanistic explanation. The qualitative data clarified the existence of quantitative relationships of how and why, and gave deeper theoretical answers. This paradigm provides a prototype for future tourism education studies. (v) Faculty Digital Readiness as Multifaceted Construct: Although earlier studies had identified the

significance of faculty readiness, the current research was able to empirically prove faculty digital readiness as a multifaceted construct, including technical competence, pedagogical adaptability, and strategic implementation knowledge. Qualitative data indicated that this construct not only features technical skills but also advanced judgment on the timing, manner, and purpose of applying technology in learning experiences. In a future study, more detailed models of faculty digital readiness may be formulated, and it may be necessary to explore how the different dimensions (technical competence vs. pedagogical adaptation vs. digital confidence) are more or less moderated by technology efficacy. (vi) Development of Critical Thinking and Problem-Solving Theory in Tourism: This study was able to develop the theoretical connection between critical thinking and problem-solving in tourism settings on an empirical basis. The direct effect (0.512) and the mediation relationship highlight the essential role of critical thinking in the development of professional problem-solving capability. This confirms the views of theorists such as Boluk et al. (2021) and Hassen (2025), who argue that tourism education should focus on the development of cognitive skills. The theory and design of future tourism education curricula can be informed by empirical evidence. (vii) Educational Technology Application to Contingency Theory: The moderation results reflect an instance of applying the contingency theory to educational technology, where technology effectiveness is based on organizational and human context. Instead of universal technology effectiveness, the study has provided contingency views that stress the interaction between the technological traits and the implementation context. This critical approach to technology contests determinist views and favors a contextual, subtle approach to technology integration. (viii) Extension of AI Scholarship to Non-Technical Areas: The vast majority of AI education research is in the area of computer science or STEM; this study expands AI education scholarship to service and hospitality-related professional areas. The conclusion that AI can develop tourism-specific cognitive abilities indicates that AI use in non-technical areas should be explored. Further study could focus on the role of AI in business, healthcare, the social sciences, and other occupational areas, thereby widening the evidence base for AI learning. (ix) Future Research Directions: This study provides a number of directions to be followed in future research. Longitudinal studies might investigate how AI-developed critical thinking and problem-solving skills in students can be maintained after graduation and applied in professional settings. Dose-response relationships could be studied in comparative studies across institutions that differ in the level of AI integration and faculty development. Qualitative studies may enhance research on the relationship between faculty practices and how student outcomes differ when faculty are digitally ready. Intervention studies may investigate the effectiveness of faculty development programs in enhancing digital preparedness and consequent student performance. Cultural studies may discuss whether the faculty digital readiness-effectiveness relationship is different under different cultural and educational settings, which would resolve the possible limitations of generalisability of research in one culture. (x) Limitations and Scope Boundaries: Findings are sound, but there are a number of limitations that should be identified. The cross-sectional study design does not allow causal inference; longitudinal studies would enhance causal assertions. The convenience sampling method can introduce selection bias; random sampling across institutions would improve generalizability. The analysis is based on tourism education in general; future studies of particular tourism specializations (hospitality, events, destinations) might show differences in the relationships. The emphasis on Asian and Middle Eastern educational settings raises concerns about generalisability to Western education systems, which may have alternative pedagogical traditions and technological infrastructure. Such restrictions imply a proper scope of findings and guidelines for further studies. Synthetically, the study reveals that AI-driven learning technologies are a potential solution to training critical thinking and problem-solving skills that are vital to tourism practitioners, provided that they are strategically implemented as part of faculty development programs and coherent curriculum development. The overall empirical evidence for all hypotheses, complemented by a qualitative investigation of the implementation mechanisms, offers practical advice and theoretical development for tourism education research and practice.

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