Artificial intelligence exposure and innovation capabilities in tourism education: the mediating role of digital creativity and absorptive capacity

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Abstract

Purpose – *This study aims to rigorously examine the impact of artificial intelligence (AI) exposure on the innovation capabilities of tourism students. Specifically, it investigates how AI influences critical competencies such as digital creativity, critical thinking, and absorptive capacity. By exploring these mechanisms, the research seeks to clarify how AI can effectively enhance student innovation within tourism education.*

Design/methodology/approach – *This study employed a quantitative survey research approach, collecting structured numerical data via an online questionnaire from 827 tourism students in Morocco. Survey research is a widely used quantitative method involving standardized questions administered to a sample, enabling measurement and statistical analysis of variables related to AI exposure, creativity and innovation. The data were analyzed using partial least squares structural equation modeling (PLS-SEM) with SmartPLS software to test the proposed hypotheses.*

Findings – *The findings reveal a positive and significant effect of AI exposure on digital creativity, critical thinking and absorptive capacity but not on problem-solving. Digital creativity and absorptive capacity were identified as mediators between AI exposure and student innovation. Additionally, experience with AI moderated the impact of absorptive capacity on innovation, indicating a nuanced and context-dependent relationship. These results highlight AI's potential to foster innovation in tourism education, particularly by enhancing creative skills and the effective utilization of knowledge.*

Originality/value – *This paper offers original insights into the role of AI in tourism education by addressing a significant gap in the literature. It provides practical implications for educational practices aimed at enhancing students' innovation capabilities. The findings have the potential to advance both pedagogical strategies and innovation outcomes within the tourism sector.*

Keywords *Artificial intelligence, Innovation, Absorptive capacity, Tourism education, Digital creativity, Critical thinking*

Paper type *Research article*

Received 18 November 2024
Revised 18 May 2025
11 September 2025
17 May 2026
Accepted 23 June 2026

Disclosure statement: No potential conflicts of interest were reported by the author.

1. Introduction

The rapid proliferation of artificial intelligence (AI) across economic sectors has fundamentally reconfigured the operational and strategic landscape of the tourism industry. As one of the most dynamic and information-intensive sectors of the global economy, tourism is particularly susceptible to—and, simultaneously, a beneficiary of—technological disruption. Innovation, broadly understood as the creation and commercialization of new or improved products, services, processes, and business models, constitutes a critical driver of competitiveness and sustainable growth within this sector (Aslan *et al*., 2021; Gan *et al*., 2023). The emergence of AI-powered tools and platforms has substantially extended the scope and pace of innovation,

enabling tourism enterprises to deploy adaptive marketing strategies, personalize customer experiences at scale, and enhance operational efficiency in ways that were previously unattainable (Xu *et al*., 2025; Yılmazdogan *et al*., 2024). Against this backdrop, the question of how tourism professionals are equipped—and, more fundamentally, how they are educated—to navigate and lead innovation in AI-mediated environments has become a matter of considerable scholarly and practical urgency (Ku and Chen, 2024).

The transformative potential of AI in higher education has attracted growing attention in recent years. AI-driven platforms such as ChatGPT and Google AI have demonstrated capacity to support personalized, adaptive, and scalable learning environments, offering tailored instructional pathways that respond to individual learner profiles, thereby fostering engagement and enhancing knowledge acquisition and retention (Akgun and Greenhow, 2022). Within the context of tourism education specifically, AI integration has been associated with the development of analytical competencies, the stimulation of entrepreneurial orientations, and the cultivation of skills aligned with contemporary industry demands (Neophytou *et al*., 2025). Moreover, scholars have emphasized that effective inter-functional coordination during AI adoption in academic institutions strengthens students' absorptive capacity—that is, their ability to recognize, assimilate, and apply externally generated knowledge—which constitutes a foundational mechanism for innovation capability development (Corcoles Munoz *et al*., 2023).

Despite these promising developments, the integration of AI into educational practice is not without tension. The risks of misinformation inherent in AI-generated content, persistent concerns regarding algorithmic bias, data privacy, and academic integrity, and the institutional challenges posed by the need for sustained faculty development and curriculum renewal represent significant obstacles that warrant careful and critical consideration (Sirkeci and Lo, 2023). Furthermore, while AI has been shown to influence cooperative behaviors and collaborative dynamics among learners (Zhang *et al*., 2023), the extent to which exposure to AI shapes the broader innovation capabilities of students—understood as the integrated capacity for digital creativity, critical thinking, and absorptive learning—remains poorly understood (Darvishi *et al*., 2024). This lacuna is particularly significant in the domain of tourism education, where preparing students to function as adaptive, innovation-oriented professionals in an AI-driven industry constitutes an explicit pedagogical imperative (Bottrill, 2022; Laachach *et al*., 2024).

The existing body of literature provides a partial and fragmented account of the relationship between AI exposure and student outcomes. While individual constructs such as engagement, motivation, and entrepreneurial intention have been examined in isolation (Neophytou *et al*., 2025), no study to date has offered a theoretically grounded and empirically rigorous account of how AI exposure, mediated or moderated by learners' prior AI experience, influences the multidimensional innovation capabilities of tourism students. This represents a critical gap in the intersection of educational technology research and tourism management scholarship. Addressing this gap is not merely an academic exercise; as the tourism industry accelerates its adoption of AI-driven tools across customer-facing and back-office functions, the capacity of its future workforce to innovate within such environments will have direct implications for organizational performance and sectoral competitiveness (Skavronskaya *et al*., 2023; Wang *et al*., 2024).

The present study responds to this imperative by investigating the following central research question: To what extent does exposure to AI influence the innovation capabilities of tourism students, and what role does prior AI experience play in moderating this relationship? In doing so, the study draws on theoretical frameworks from absorptive capacity theory and innovation management, integrating them with empirical insights from the tourism education literature to construct a conceptual model that captures the complexity of the AI–innovation capability nexus. The remainder of this paper is organized as follows. The subsequent section reviews the theoretical and empirical literature underpinning the study's core constructs—AI exposure, digital

creativity, critical thinking, and absorptive capacity—and develops the hypotheses that structure the empirical inquiry. The methodology section details the research design, sampling strategy, measurement instruments, and analytical procedures employed. The results are then presented, followed by a discussion that situates the findings within the broader scholarly conversation. The paper concludes by articulating the study's theoretical contributions, its implications for the design and delivery of tourism curricula, and avenues for future research.

2. Literature review

This study examines the impact of AI on innovation capabilities in tourism education by building on cognitive learning theories (Gibson *et al.*, 2023; Jaboob *et al.*, 2025). These theories are increasingly combined with AI research to explore AI's transformative effects in education (AlShaikh *et al.*, 2024). Gibson *et al.* (2023) propose a comprehensive three-level framework—micro (individual), meso (group), and macro (cultural)—that integrates cognitive, sociocultural, and constructivist perspectives to explain AI's multifaceted role in learning. At the individual level, AI's adaptive learning and personalized feedback align with cognitive theories emphasizing active mental engagement and knowledge construction. At the group level, AI facilitates collaborative knowledge building and critical thinking, echoing sociocultural learning theories. At the societal level, AI drives cultural shifts in knowledge and skills, illustrating learning's broader impact. This integrated framework demonstrates how AI can function as a co-agent in enhancing students' digital creativity, critical thinking, and absorptive capacity (Gibson *et al.*, 2023).

Beyond this cognitive and sociocultural integration, AI applications in tourism education enrich pedagogical methods by enabling personalized, interactive experiences such as virtual reality simulations and chatbot interactions (Demir, 2024). These tools promote higher-order thinking skills—including critical thinking and problem-solving—in line with constructivist learning principles. However, emerging ethical concerns, particularly regarding academic integrity, must be carefully addressed (Skavronskaya *et al.*, 2023).

While prior studies emphasize AI's ability to personalize learning based on individual styles (Doğan and Niyet, 2024), the role of creative confidence as a moderating factor remains insufficiently studied. Creative confidence—the belief in one's capacity to generate novel ideas and solutions (Choi *et al.*, 2025) —can significantly affect how students use AI technologies to foster innovation. Integrating this concept theoretically would deepen understanding of variations in learning outcomes and should be prioritized in future research.

This review also identifies gaps in understanding how AI influences students' attitudes and cognitive capacities over time. It proposes new mediating and moderating relationships to better capture these dynamics. Accordingly, this study advances the literature by developing propositions that incorporate these theoretical refinements, contributing to a more nuanced understanding of AI's role in promoting innovation in tourism education.

2.1 Linking artificial intelligence with the tourism sector

The integration of AI across various sectors has brought significant transformations to organizations, societies, and individuals (Dwivedi *et al.*, 2024). In the travel, tourism, and hospitality sector, evolving customer expectations have accelerated the adoption of AI-driven technologies, such as interactive platforms and self-service tools, enabling marketers to enhance customer experiences (Samala *et al.*, 2022). AI contributes to operational efficiency through automation processes, including robotics for check-ins and baggage handling, while also facilitating personalized customer interactions via chatbots and virtual assistants (Gul *et al.*, 2025). Moreover, predictive analytics provide dynamic capabilities for demand forecasting and pricing optimization, which are essential for strategic decision-making (Samara *et al.*, 2020).

Despite these advances, challenges persist, including digital skill gaps within the workforce, highlighting the urgent need for upskilling to fully capitalize on AI's benefits (Carlisle *et al*., 2023). Additionally, AI applications that enhance cross-cultural communication—such as automatic language translation and sentiment analysis—are playing increasingly important roles in improving visitor satisfaction (Knani *et al*., 2022; Samala *et al*., 2022).

While the literature offers a comprehensive overview of AI's effects on operational processes and customer experience in tourism, a significant theoretical and empirical gap exists regarding its impact on tourism education and student experiences (Sanusi *et al*., 2022). In particular, constructs such as creative confidence as moderators remain insufficiently theorized. Creative confidence strongly influences how students use AI tools for innovation but requires more thorough conceptual exploration within the context of tourism education. Addressing this gap is essential for understanding individual differences in AI adoption and effectiveness in educational settings.

2.2 Linking artificial intelligence with the education sector

The integration of AI across various sectors, including travel, tourism, and hospitality, has driven significant changes by transforming operational processes, customer experiences, and decision-making (Dwivedi *et al*., 2024; Samala *et al*., 2022). AI technologies such as robotics, chatbots, virtual assistants, and predictive analytics enhance efficiency, personalization, and resource optimization (Knani *et al*., 2022). However, challenges remain, especially the digital skills gap that may limit equitable access to and full utilization of AI's potential (Carlisle *et al*., 2023).

Despite well-established impacts on service and operational aspects of tourism, the literature exhibits a notable gap concerning AI's influence on tourism education and student experiences (Sanusi *et al*., 2022). Synthesizing these insights underscores the need for future research to rigorously conceptualize and empirically examine creative confidence within AI-enhanced learning frameworks in order to better understand its moderating effects on innovation outcomes.

2.3 Artificial intelligence in education and creativity

The literature shows that students' creativity is influenced by digital technology products, with effects varying according to the cognitive demands these technologies impose (Habib *et al*., 2024). For example, virtual reality (VR) can increase cognitive load, which may negatively impact certain aspects of creativity in students (Chen *et al*., 2021). However, emerging research highlights AI's potential to support creativity by fostering related skills such as curiosity, grit, persistence, and attentiveness—essential traits for creative thinking (Belpaeme *et al*., 2018). Innovative methodologies, such as latent semantic analysis, have been applied to objectively assess creativity in academic tasks by measuring creative responses (Beaty and Johnson, 2021).

According to the National Advisory Committee on Creative and Cultural Education, fostering creativity involves empowering students to believe in their creative abilities and building their confidence to experiment and innovate. AI increasingly facilitates personalized, adaptive learning environments that enhance student experiences while complementing, rather than replacing, the crucial role of teachers (Holmes and Tuomi, 2022). This shift underscores a complementary relationship between AI and human intelligence. Research confirms that AI tools, such as ChatGPT, enhance learning tasks but cannot fully replace human creative judgment (Shoufan, 2023).

In tourism education, interaction with AI technologies like machine learning and natural language processing encourages students not only to use innovative digital tools but also to adopt creative and unconventional approaches in their application (Neophytou *et al*., 2025). Empirical studies confirm that embedding AI in educational settings fosters experimentation and digital creativity (Bender, 2023). Digital creativity—the generation of novel ideas, solutions, and expressions through proficient use of technology—aligns with critical making principles that emphasize

hands-on engagement and sociocultural reflection (Schwartz *et al*., 2004). Grounded in cognitive learning theories that stress active engagement and higher-order cognitive skill development, this foundation proposes that AI exposure enriches tourism students' learning by promoting digital creativity, critical thinking, and problem-solving through personalized and adaptive instructional pathways (Biriescu and Olteanu, 2025; El-Akhras *et al*., 2025).

Building on this comprehensive framework, the following hypothesis is proposed:

H1. AI exposure has a positive effect on digital creativity among tourism students.

2.4 Artificial intelligence in education and critical thinking

The impact of AI on critical thinking in educational settings is well documented but yields mixed results, requiring a nuanced theoretical approach. Cognitive learning theories emphasize developing higher-order cognitive skills—such as analysis, evaluation, and synthesis—through active mental engagement and reflective practice (Reigeluth and Moore, 2013). AI technologies, including chatbots and adaptive learning platforms, have the potential to support these cognitive processes by offering personalized feedback and promoting metacognitive awareness. However, empirical evidence indicates that this influence depends on the design and context of AI integration. For example, Deng and Yu (2023) found that chatbot-assisted learning improves overall outcomes but may have limited impact on critical thinking depending on the nature of the interaction. Other studies show that AI tools aimed at countering misinformation (Musi *et al*., 2023) or fostering collaborative learning (Gonzalez-Cacho and Abbas, 2022) can enhance critical faculties.

Drawing on absorptive capacity theory, which emphasizes not only acquiring but also assimilating and applying knowledge, this study conceptualizes critical thinking as an intermediary cognitive capacity that enables effective knowledge use in innovative contexts (Zahra and George, 2002). AI exposure thus creates learning environments wherein tourism students can develop critical thinking skills through adaptive, context-sensitive educational experiences that support both cognitive growth and knowledge application.

Based on this theoretical synthesis, the study proposes:

H2. AI exposure has a positive effect on critical thinking skills among tourism students.

2.5 Artificial intelligence in education and absorptive capacity

In educational contexts, students often struggle to effectively assimilate and apply new information despite enriched instructional content (Martín-Rodríguez and Madrigal-Cerezo, 2025). This underscores the critical importance of absorptive capacity, a multidimensional cognitive ability encompassing four interconnected processes: acquisition, assimilation, transformation, and exploitation of knowledge (Zahra and George, 2002). Acquisition involves identifying and valuing new external knowledge, while assimilation refers to analyzing and interpreting this knowledge for comprehensive understanding. Transformation entails refining and integrating new knowledge with existing cognitive frameworks to enhance routines. Exploitation concerns applying this transformed knowledge to produce practical and innovative outcomes. Although these dimensions have been primarily examined at the organizational level, they are equally applicable to individual learners, especially in dynamic, technology-enhanced educational environments.

Building on cognitive learning theory, which emphasizes active knowledge construction through these stages, this study conceptualizes absorptive capacity as a second-order construct integrating acquisition, assimilation, transformation, and exploitation (Hashem, 2024; Zahra and George, 2002). AI exposure is posited to enhance each cognitive process by offering adaptive learning experiences, personalized feedback, and improved access to digital knowledge

repositories, thereby fostering deeper understanding and practical application of knowledge (Zhang *et al*., 2025; Hashem, 2024). This theoretical integration provides a comprehensive foundation illustrating how absorptive capacity mediates the effect of AI exposure on innovation capabilities in tourism education. Based on this framework, the study hypothesizes that:

H3. AI exposure has a positive effect on absorptive capacity among tourism students.

2.6 Artificial intelligence in education and problem-solving

Problem-solving is defined as the cognitive process through which individuals identify, analyze, and overcome obstacles to achieve specific objectives (Pedersen and Liu, 2002). The integration of AI in educational settings has increasingly been explored for its potential to enhance these skills, as AI systems can emulate human cognitive functions via advanced programming and machine learning (Alchihabi *et al*., 2021). Cognitive learning theory highlights active cognitive engagement, scaffolding, and feedback as essential for skill acquisition (Reigeluth and Moore, 2013). AI-powered tools, such as intelligent tutoring systems and adaptive chatbots, embody these principles by providing personalized feedback and fostering metacognitive reflection, both critical for developing effective problem-solving abilities (Peng *et al*., 2024).

Empirical evidence supports these theoretical insights, showing that AI-assisted educational interventions—including robotics-based programming and chatbot-facilitated learning—significantly improve students' problem-solving skills and computational thinking (Yilmaz and Yilmaz, 2023). However, the degree of this enhancement depends on the sophistication of AI system design and their ability to support authentic, higher-order cognitive tasks.

Building on these cognitive and technological perspectives, this study hypothesizes that:

H4. AI exposure has a positive effect on problem-solving among tourism students.

2.7 The indirect impact of artificial intelligence exposure on innovative capabilities of students

Exposure to AI tools enhances students' innovation capabilities (Tan, 2023) through its influence on digital creativity, which serves as the key mediating mechanism in this relationship. From a social cognitive perspective, students develop cognitive and creative capabilities through interaction with AI systems that provide feedback, alternative solutions, and exposure to diverse problem-solving approaches, thereby supporting observational and experiential learning processes (Bandura, 1986). By continuously engaging with AI-generated outputs, learners refine how they frame problems, evaluate alternatives, and recombine ideas, which strengthens their digital creativity as a higher-order cognitive skill. In addition, AI technologies reduce the cognitive burden associated with routine and repetitive tasks, allowing students to allocate greater cognitive resources to reflection, ideation, and innovative thinking (Dell'Acqua *et al*., 2023). As a result, digital creativity becomes the central pathway through which AI exposure translates into enhanced innovation capabilities, by enabling students to transform AI-supported insights into original and applicable solutions.

H5. Digital creativity mediates the influence of AI exposure on tourism students' innovation capabilities.

AI technologies support evidence-based reasoning and analytical evaluation by offering learners access to extensive data and tools that challenge assumptions (Muthmainnah *et al*., 2022). Critical thinking equips students to identify biases and make informed decisions, skills that are fundamental to innovation in complex tourism environments (Gao *et al*., 2025). Therefore, AI-driven enhancement of critical thinking functions as a crucial cognitive process that converts technology exposure into innovation outcomes.

H6. Critical thinking mediates the influence of AI exposure on tourism students' innovation capabilities.

AI systems aid problem-solving by assisting learners in structuring complex tasks, modeling scenarios, and evaluating potential outcomes using simulations and adaptive feedback (Almulla, 2023). This iterative refinement process cultivates students' abilities to develop practical and innovative solutions within tourism. As a result, improved problem-solving skills acquired through AI use serve as a direct pathway for enhancing innovation capabilities.

H7. Problem-solving mediates the influence of AI exposure on tourism students' innovation capabilities.

Absorptive capacity—the ability to identify, assimilate, and apply new knowledge—is essential for transforming AI-enabled information into actionable innovation (Zahra and George, 2002). Research shows that exposure to AI accelerates knowledge acquisition and supports cognitive processes that enhance understanding (Hashem, 2024; Zhang *et al*., 2025). This strengthened absorptive capacity converts AI-driven learning into measurable innovation performance, acting as a key mediator.

H8. Absorptive capacity mediates the influence of AI exposure on tourism students' innovation capabilities.

These hypotheses establish a framework for exploring the mechanisms by which AI exposure enhances tourism students' innovation capabilities, thereby advancing understanding of the role cognitive abilities play in the innovation process.

2.8 The moderating effects of creative confidence and experience with AI

Creative confidence plays a key role in shaping how students engage with and benefit from AI technologies in educational settings. Lee (2020) shows that fostering creative confidence through interdisciplinary creativity courses significantly increases students' willingness to face creative challenges and reshape their creative identity. This aligns with the view that creative confidence influences both motivation and the ability to embrace innovative tasks.

While creative confidence is incorporated as a moderator on a single path—namely, the relationship between AI exposure and digital creativity—its inclusion is theoretically deliberate rather than incidental. Creative confidence, defined as an individual's belief in their capacity to generate novel ideas and engage with creative challenges (Choi *et al*., 2025), is a dispositional factor that is most consequential precisely at the intersection of technology exposure and creative output. Students with higher creative confidence are more likely to actively appropriate AI tools for generative and exploratory purposes, rather than using them instrumentally (Liu *et al*., 2023). Since digital creativity represents the cognitive pathway most directly shaped by individual-level creative dispositions, positioning creative confidence as a moderator on this specific relationship is both conceptually precise and analytically parsimonious. This targeted specification is consistent with established moderation modeling practice, which does not require a moderator to operate uniformly across all hypothesized paths to be theoretically meaningful or empirically valuable.

Accordingly, this leads to the hypothesis that:

H_a. Creative confidence moderates the relationship between AI exposure and digital creativity

Although AI exposure and experience with AI may appear conceptually proximate, they occupy distinct theoretical roles within the proposed framework and should not be treated as interchangeable. AI exposure refers to the extent of students' curriculum-mediated contact with AI-powered tools—an externally driven, contextual condition that varies across academic programs and institutional environments (Wang and Peng, 2023). As such, it functions in this

study as the independent variable that activates the mediating mechanisms of digital creativity, critical thinking, and absorptive capacity. Experience with AI, by contrast, captures the depth and quality of an individual's accumulated prior engagement with AI technologies—an internalized, skill-relevant attribute that the student brings to the learning context. Critically, exposure does not presuppose experience: a student may regularly encounter AI tools within a curriculum without having developed substantive prior competence in their use. It is this individual-level variation in experience that endows it with moderating power, conditioning the strength of the relationship between absorptive capacity and innovation capabilities. These two constructs are therefore structurally non-redundant and serve complementary analytical functions within the model.

Students' prior experience with AI, alongside foundational skills like digital creativity, critical thinking, problem-solving, and absorptive capacity, collectively influence their overall innovation capabilities. AI tools can cater to varying skill levels by providing personalized support for novices while empowering experienced users to extend innovative performance. This perspective aligns with research highlighting the moderating effect of experience on learning outcomes (Guan *et al*., 2020). Based on this understanding, the following hypotheses are proposed:

H_b. Experience with AI moderates the relationship between Digital creativity and Tourism Students' Innovation Capabilities

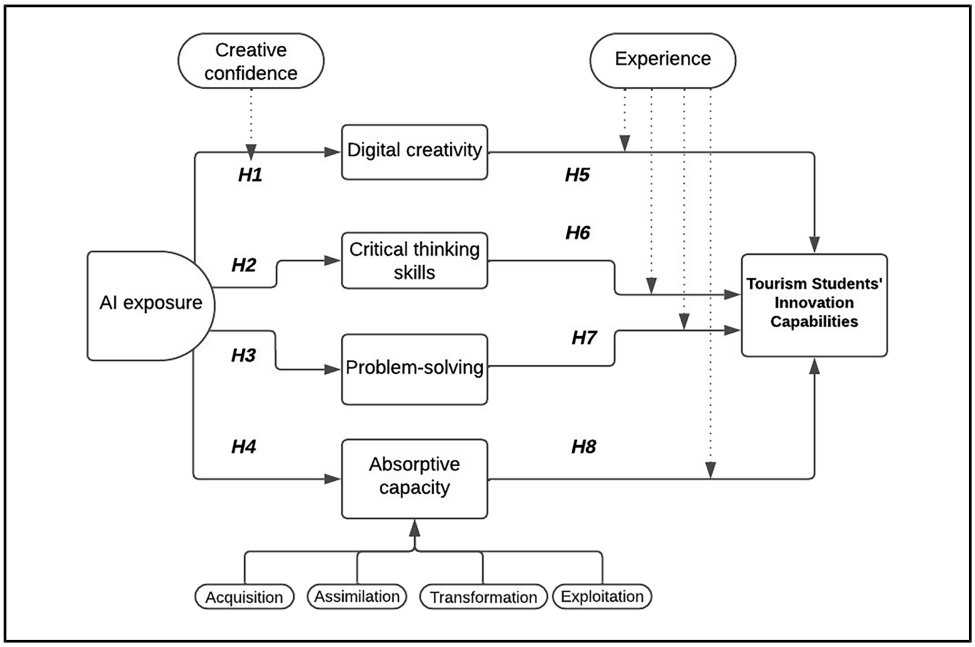
H_c. Experience with AI moderates the relationship between Critical thinking and Tourism Students' Innovation Capabilities

H_d. Experience with AI moderates the relationship between Problem-solving and Tourism Students' Innovation Capabilities

H_e. Experience with AI moderates the relationship between Absorptive capacity and Tourism Students' Innovation Capabilities

The summarized research framework is presented in Figure 1.

Figure 1 Research framework



3. Methodology

3.1 Data collection

Participants were selected using a purposive sampling strategy targeting tourism students enrolled in various academic levels of tourism-related programs to ensure relevance to the study's focus on innovation capabilities. The sample was primarily drawn from the Higher International Institute of Tourism of Tangier, Morocco, focusing on individuals with direct exposure to AI technologies within their academic curriculum. Purposive sampling was considered appropriate as it provides in-depth insights from participants possessing the key characteristics necessary to understand AI's impact in tourism education.

To enhance sample diversity and accessibility, a multi-channel questionnaire distribution method was employed. Survey links were disseminated through a wide network of professors teaching tourism courses, shared on dedicated online platforms for tourism students, and administered in person during seminar sessions at the Institute. Data collection took place between April 1 and May 15, 2024, resulting in 827 responses. After data cleaning, seven incomplete responses were excluded using listwise deletion, yielding a final sample of 820 valid responses. With less than 1% data loss, this approach preserved data integrity and representativeness (Newman, 2014).

This systematic data collection approach enabled the capture of valuable information from students with diverse tourism specializations, providing a strong foundation for analyzing and interpreting the study's results.

Prior to analysis, the data were meticulously cleaned using SPSS software. Missing values were addressed through listwise deletion, resulting in the exclusion of 1% of incomplete cases. Outliers were identified by examining standardized scores (Z-scores) with a ±3 threshold and by assessing Mahalanobis distance to detect multivariate anomalies. Identified outliers and anomalous cases were carefully reviewed and removed when justified to prevent biasing the results (Rasmussen, 1988). Furthermore, checks for duplicates and inconsistencies were conducted and corrected as needed. These procedures ensured the data's integrity and reliability for subsequent analyses.

3.2 Measures and analysis

This study employed seven latent constructs: AI Exposure, Creative Confidence, Digital Creativity, Critical Thinking Skills, Problem-Solving, Absorptive Capacity, and Tourism Students' Innovation Capabilities. These constructs have been validated in prior research (Wang and Peng, 2023; Dosi *et al*., 2018; Shao *et al*., 2022; Korkmaz *et al*., 2017; Zahra and George, 2002; Cheng and Chen, 2013).

All constructs were measured using a seven-point Likert scale (see Table 1). To ensure validity and reliability, two expert researchers in the study's field reviewed the questionnaire. They agreed with most items but recommended modifications to three absorptive capacity items and two tourism

Table 1 Constructs and items

Constructs	*Number of items*	*References*
AI exposure	4 items	Wang and Peng (2023)
Creative confidence	4 items	Dosi *et al*. (2018)
Digital creativity	4 items	Shao *et al*. (2022)
Critical thinking skills	3 items	Korkmaz *et al*. (2017)
Problem-solving	3 items	Korkmaz *et al*. (2017)
Absorptive capacity	14 items	Zahra and George (2002) Laachach and Ettahri (2023)
Tourism Students' Innovation Capabilities	5 items	Cheng and Chen (2013)

students' innovation capabilities items, as well as clarifications on several others. The questionnaire was revised accordingly to improve readability and comprehension.

The final questionnaire consisted of eight sections. The first section gathered sociodemographic data such as gender, age, region, marital status, qualifications, education level, specialization, and AI experience. The detailed measurement items are presented in Table A1 in the Appendix. No original scale items were omitted, although some were adapted to better fit the study context. Absorptive Capacity was conceptualized as a second-order construct, comprising four first-order dimensions: Acquisition, Assimilation, Transformation, and Exploitation. All constructs and their items were specified as reflective measurement models.

In this study, all constructs were modeled as reflective in the PLS-SEM analysis based on both theoretical and empirical grounds consistent with prior research. Reflective measurement models posit that the latent construct causes the observed indicators; hence, the indicators represent manifestations of the same underlying concept and are expected to be highly correlated (Hair *et al*., 2019). This conceptualization aligns with the constructs used—such as AI Exposure (Wang and Peng, 2023), Creative Confidence (Dosi *et al*., 2018), Digital Creativity (Shao *et al*., 2022), Critical Thinking Skills and Problem-Solving (Korkmaz *et al*., 2017), Absorptive Capacity (Zahra and George, 2002), and Tourism Students' Innovation Capabilities (Cheng and Chen, 2013)—which are latent variables reflected by their respective items.

Each construct's items serve as theoretically interchangeable indicators representing a common underlying factor; consequently, changes in the latent construct are expected to produce changes in all indicators. This reflective specification is further substantiated by evaluating indicator loadings, internal consistency reliability, convergent validity (e.g. Average Variance Extracted), and discriminant validity, in accordance with established PLS-SEM guidelines (Hair *et al*., 2020). Thus, modeling the constructs as reflective is both conceptually appropriate and methodologically sound, ensuring valid and reliable measurement within the PLS-SEM framework.

To examine the complex relationships among variables, Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen as the analytical method. This robust technique is well suited for handling non-normal data distributions and complex models with reflective constructs, particularly with small to medium sample sizes (Sarstedt *et al*., 2022; Hair *et al*., 2019). PLS-SEM allows simultaneous assessment of measurement model validity and structural relationships, with significance testing performed via bootstrapping to enhance result robustness.

Tests for data normality using Shapiro-Wilk and Kolmogorov-Smirnov in SPSS indicated non-normal distributions (Hung and Hsu, 2011). Additional skewness and kurtosis analyses confirmed slight deviations from normality (Hair *et al*., 2019), though most items' values remained within the acceptable range of -1 to $+1$, as per Hair *et al*. (2012).

The selection of PLS-SEM was further justified by its capacity to produce explanatory and predictive results, enabling practical implications to be drawn from the study (Hair *et al*., 2019). SmartPLS version 4.1.0.2 was used to validate both the measurement and structural models, ensuring robust and valid analysis (Ringle *et al*., 2023).

Evaluating the measurement model entails comprehensive assessment of multiple properties, including:

1. *Indicator reliability*: Examining the extent to which each indicator (item) is related to its corresponding construct.
2. *Internal consistency reliability*: Assessing the consistency of results across items within a construct.
3. *Convergent validity*: Determining if items that should be related are, in fact, related.
4. *Discriminant validity*: Ensuring that constructs that should not be related are, in fact, not related.

The meticulous evaluation of a structural model, particularly when composed of reflective constructs, necessitates a rigorous examination of several key elements:

1. *Collinearity*: Assessing the degree of multicollinearity among predictor constructs.
2. *Predictive relevance (R^2 and Q^2)*: Evaluating the model's ability to predict the endogenous constructs.
3. *Significance and relevance of path coefficients*: Determining the strength and direction of the relationships between constructs.

In this study, measurement quality was ensured through rigorous assessment of reliability and convergent validity. Reliability was evaluated using Cronbach's alpha and Composite Reliability (CR), with values above 0.7 indicating consistent and dependable results. Convergent validity was assessed following Fornell and Larcker's (1981) criteria: individual item loadings exceeding 0.70, demonstrating strong relationships between items and their constructs, and Average Variance Extracted (AVE) values above 0.50, indicating that constructs effectively explain the variance of their measures. Additionally, bootstrapping with 5,000 replications was employed to generate reliable estimates of sampling errors, yielding more robust standard errors than traditional methods. This comprehensive approach ensured that the measures were both reliable and conceptually meaningful, thereby strengthening the study's empirical foundation.

4. Results and discussion

Table 2 presents the demographic and academic profile of respondents, reflecting a robust and diverse Moroccan tourism student population with varied experiences of AI integration in their education.

Table 2 Respondents' profile

Variable	*Frequency*	*Percentage (%)*
Gender		
Male	560	68.30%
Female	260	31.70%
Age		
<23	599	73.05%
[24–35]	215	26.22%
[36–45]	6	0.73%
Educational level		
High School Diploma (Bac)	25	3.05%
Bachelor's Degree (Bac+1)	75	9.15%
Two-year Post-secondary Degree (Bac+2)	110	13.41%
Bachelor's Degree (Bac+3)	214	26.10%
Master's Degree (Bac+4)	170	20.73%
Master's Degree (Bac+5)	220	26.83%
PhD Student	6	0.73%
Experience with AI		
No experience	0	0.00%
Very little experience	22	2.68%
Limited experience	80	9.76%
Moderate experience	420	51.22%
Significant experience	210	25.61%
Extensive experience	75	9.15%
Expert experience	13	1.59%

Note(s): $N = 820$

The survey participants were predominantly young, with over 73% under 23 years old and smaller proportions in the 24–35 and 36–45 age groups. Males constituted the majority of respondents (68%). Most participants were enrolled at the Master's level, followed closely by Bachelor's students, reflecting their active academic status crucial for assessing current AI exposure and its impact on innovation capabilities. Additionally, the majority reported having some level of AI experience, with moderate experience being the most common; notably, no respondents reported having no AI experience, indicating a baseline familiarity with the technology within the sample.

The study assessed common method bias (CMB) using Harman's one-factor test, which showed that a single factor accounted for 45.00% of the total variance—just below the conventional 50% threshold (Fuller *et al*., 2016). Although this value is relatively high, it does not conclusively indicate severe bias. To further reduce potential CMB effects, procedural safeguards were applied, including ensuring respondent anonymity, counterbalancing item order, and designing clear, concise survey items to minimize patterned responses and social desirability bias. Together with the Harman's test result, these steps support the conclusion that common method bias is unlikely to have significantly affected the study's findings (Fuller *et al*., 2016). This finding indicates that common method bias does not significantly threaten the validity of the study's results. Further validation was conducted using the heterotrait–monotrait (HTMT) ratio of correlations (Hair *et al*., 2019). The HTMT ratios exceeded the 0.700 threshold across multiple relationships, confirming the discriminant validity of the constructs. To evaluate non-response bias, the study applied the extrapolation method by comparing early and late respondents as per Armstrong and Overton (1977). An independent-samples *t*-test found no significant differences ($p > 0.05$) between the first and last 50 responses, suggesting non-response bias is not a concern here. Together, these analyses reinforce the robustness of the findings and confirm that neither common method bias nor non-response bias undermines the integrity of the collected data.

4.1 Assessing measurement models

Table A2 in the Appendix presents the convergent validity results. Discriminant validity was assessed using the Fornell–Larcker criterion (see Appendix Table A3), confirms that the measures correspond to distinct constructs. This separation is further reinforced by Appendix Table A4, where correlations between different constructs are consistently lower than the shared variance between each construct and its indicators, indicating minimal conceptual overlap. The comprehensive model structure depicted in Figure 1 includes six distinct measurement models linking observed variables to their latent constructs, alongside a structural model illustrating the hypothesized relationships among these variables. Collectively, these analyses validate the clear delineation of unique, non-overlapping constructs and accurately capture their expected interactions within the proposed theoretical framework.

4.2 Assessing structural model

The researchers went beyond demonstrating theoretical soundness (good fit) by assessing how well their model predicts real-world outcomes. To do this, they applied a suite of established evaluation metrics—such as R-square and Q^2 predict—outlined by Hair *et al*. (2019). The key results are summarized in Table 3 for detailed examination. This comprehensive approach evaluated the model's performance across several critical dimensions:

1. Explaining Past Data (R-square): Evaluates how well the model accounts for variation in outcome variables using existing data.
2. Predicting New Information (Q^2 predict): Measures the model's ability to accurately forecast outcomes in new, unseen scenarios.
3. Outperforming Chance (NFI, SRMR): Assesses whether the model provides significantly better explanation and prediction than random guessing.

Table 3 Evaluation results of the structural model

	Saturated model	*Estimated model*
SRMR	0.082	0.096
d_ULS	4.706	6.452
d_G	5.135	5.360
Chi-square	2311.013	2476.767
NFI	0.535	0.502
Tourism students' _innovation capabilities		
R-square	0.703	
R-square adjusted	0.679	
Q^2predict	0.518	

4. Matching Reality (SRMR): Examines how closely the model's predictions correspond to actual observed data.

Together, these metrics provide a thorough assessment of the model's explanatory and predictive strengths as well as its alignment with empirical observations.

The model addresses potential endogeneity by explaining over 70% of the variance in key variables, exceeding Chin's (1998) recommended threshold. Predictive validity is supported by a strong Q^2 predict value of 0.518 (Hair *et al*., 2019). Additionally, the model shows minimal discrepancy (SRMR = 0.082) and a satisfactory overall fit (NFI = 0.535), indicating good model adequacy (Hair *et al*., 2019). Collectively, these metrics confirm the model's robustness and solid performance.

To investigate hypothesized direct and moderating effects more deeply, a bootstrapping procedure with 5,000 subsamples and the PLS algorithm was employed. Detailed results of these analyses are provided in Table 4.

Multicollinearity among independent variables was evaluated using Variance Inflation Factors (VIF). All VIF values were below the accepted threshold of 5, indicating no significant multicollinearity. This confirms that independent variables are sufficiently distinct, enhancing the model's robustness and reliability of inferences.

4.3 Directs relationships

4.3.1 Digital creativity. The finding that AI exposure positively and significantly enhances digital creativity among tourism students is particularly important. In tourism, digital creativity is increasingly vital as the industry integrates new technologies and digital platforms to engage customers and deliver immersive experiences. AI-powered tools, such as text-to-image generators, act as powerful catalysts for unleashing students' creativity, enabling them to visualize evocative travel scenes and bring ideas to life in novel ways. Incorporating AI-driven technologies into tourism curricula can thus foster digital creativity, equipping students with the skills to design innovative tourism products, create compelling digital content, and captivate audiences online.

This result aligns with Reddy's (2022) concept of "artificial everyday creativity," where AI co-creates with humans in crafts, enhancing rather than replacing creativity through "critical making" that blends technology and craftsmanship. Our study confirms that AI exposure boosts digital creativity in tourism students (see Table 4), supporting the hypothesis that AI equips students with tools to increase originality and efficiency, allowing personalized work. This generation thrives on "assisted generation," using the right tools for the task, further explaining the observed link.

Moreover, the positive effect of digital creativity on student innovation underscores the value of "learning by doing." Students actively engaging with tasks, often aided by AI tools, generate fresh,

Table 4 Hypotheses test results

		Original sample (O)	*Sample mean (M)*	*Standard deviation (STDEV)*	*T statistics (|O/STDEV|)*	p *values*	*Decision*
H1	AI_Exposure → Digital creativity	0.382	0.383	0.081	4.716	0.000	Supported**
H2	AI_Exposure → Critical Thinking	0.528	0.540	0.075	7.039	0.000	Supported**
H3	AI_Exposure → Problem Solving	−0.057	−0.073	0.116	0.493	0.622	Not supported
H4	AI_Exposure → Absorptive capacity	0.681	0.688	0.066	10.349	0.000	Supported**
H5	Digital creativity → Tourism Students' _Innovation Capabilities	0.285	0.268	0.083	3.423	0.001	Supported**
H6	Critical Thinking → Tourism Students' _Innovation Capabilities	0.086	0.098	0.088	0.973	0.330	Not supported
H7	Problem Solving → Tourism Students' _Innovation Capabilities	−0.187	−0.176	0.082	2.287	0.022	Not supported
H8	Absorptive capacity → Tourism Students' _Innovation Capabilities	0.587	0.586	0.093	6.280	0.000	Supported**
	Hypotheses (moderation effects)						
H_a	Creative confidence × AI_Exposure → Digital creativity	0.192	0.195	0.074	2.583	0.010	Supported**
H_b	Experience × Digital creativity → Tourism Students' _Innovation Capabilities	0.173	0.149	0.109	1.591	0.112	Not supported
H_c	Experience × Critical Thinking → Tourism Students' _Innovation Capabilities	0.069	0.064	0.103	0.668	0.504	Not supported
H_d	Experience × Problem Solving → Tourism Students' _Innovation Capabilities	−0.012	−0.008	0.073	0.170	0.865	Not supported
H_e	Experience × Absorptive capacity → Tourism Students' _Innovation Capabilities	0.152	0.115	0.054	2.303	0.000	Supported**

Note(s): **: highly significant if *p*-value ≤0.01 *: significant if *p*-value <0.05

innovative ideas. This supports existing research (e.g. Noy and Zhang, 2023; Yılmaz and Yılmaz, 2023) demonstrating how tools like ChatGPT empower students to produce more original and complex work.

4.3.2 Critical thinking skills. The findings indicate that engagement with AI-powered tools enhances students' abilities to analyze data, identify patterns, and evaluate technological implications (Essien *et al*., 2024). This development of critical thinking skills equips students to effectively navigate the evolving tourism sector and foster innovation. However, the study also highlights concerns regarding the reliability, accuracy, and ethical considerations of using AI within higher education contexts (Darwin *et al*., 2024). Students recognized AI's usefulness in enhancing critical thinking by enabling them to address complex problems, analyze large datasets, and systematically compare alternatives in the tourism field, as reflected in the questionnaire responses. The study concludes that AI serves as a valuable tool for developing critical thinking skills, particularly by supporting information assessment and analytical reasoning. This aligns with research on AI friend apps in English language learning, which indicate that such tools positively impact critical thinking development by fostering trust, self-confidence, and open-mindedness (Muthmainnah *et al*., 2022). Overall, the findings underscore AI's potential to enhance critical thinking skills among tourism students, while also emphasizing the importance of careful management and awareness of the technology's limitations and ethical considerations.

4.3.3 Absorptive capacity. Absorptive capacity—the ability to acquire, assimilate, transform, and apply knowledge—is vital for success in the rapidly evolving tourism sector. The findings suggest that engagement with AI-driven technologies enhances students' capacity to acquire and apply new knowledge, enabling them to stay abreast of industry trends and continuously develop their

skills. This empowerment allows students to effectively leverage AI-generated insights to inform decision-making and innovation, resulting in more personalized, efficient, and sustainable tourism products and services (Laachach and Alhemimah, 2024).

These results align with prior research demonstrating that absorptive capacity facilitates technology adoption and practice innovation in businesses (Tu *et al*., 2006), fosters regional innovation (Fu, 2008), and enhances collaboration and innovation in tourism marketing (Kim and Tussyadiah, 2013). Recent studies also highlight AI's role in improving efficiency and profitability in tourism and boosting performance for small and medium enterprises (Wahab and Radmehr, 2024). The study confirms that user-friendly AI tools simplify learning and knowledge transfer for students, thereby strengthening their absorptive capacity (Harisankar *et al*., 2024). Students who actively use AI tools in problem-solving exhibit stronger abilities to acquire, integrate, and transform information into innovative solutions.

4.3.4 AI exposure, problem-solving, critical thinking and innovation capabilities. This study examined the impact of AI exposure on problem-solving skills among tourism students and found no positive and significant relationship, contrary to prior research (Tendulkar *et al*., 2023; Shah and Asad, 2024; Garbuio and Lin, 2021). Notably, a negative path was observed from problem-solving to innovation. Several explanations may account for these findings. First, the AI technologies used in the tourism curriculum might focus more on procedural automation than on fostering the complex cognitive engagement needed for advanced problem-solving and innovation (Tendulkar *et al*., 2023). Second, critical thinking and problem-solving may not act as direct mediators between AI exposure and innovation in this educational context, indicating more complex, indirect pathways (Shah and Asad, 2024). Third, the tourism sector's emphasis on interpersonal, creative, and context-sensitive skills may limit the extent to which AI-assisted problem-solving translates into innovation (Garbuio and Lin, 2021).

Moreover, recent research suggests that excessive reliance on AI tools without deliberate pedagogical support can hinder the development of independent critical thinking and creative problem-solving (Hou *et al*., 2025). These results challenge simplistic linear models of causality and call for more nuanced frameworks integrating cognitive, contextual, and affective factors influencing innovation in tourism education. Future research should investigate additional mediators such as creativity, adaptability, and entrepreneurial mindset, as well as explore how AI integration can be optimized to nurture these key competencies essential for promoting innovation. The study finds that AI exposure does not have a positive and significant effect on problem-solving skills among tourism students, contrary to prior research. Notably, a negative relationship emerged between problem-solving and innovation. Possible explanations include the emphasis of AI tools in the curriculum on procedural automation rather than fostering complex cognitive engagement, the indirect role of critical thinking and problem-solving as mediators between AI exposure and innovation, and the unique tourism sector demands for interpersonal and creative skills that may limit AI's impact on problem-solving innovations. Emerging evidence also warns that heavy reliance on AI tools without targeted pedagogical interventions may impede the development of independent critical thinking and problem-solving skills. These findings urge the adoption of more nuanced theoretical models integrating cognitive, contextual, and affective dimensions in tourism education innovation research. Future studies could explore mediators such as creativity, adaptability, and entrepreneurial mindset and investigate ways to optimize AI use to support these competencies critical for innovation. The findings of this study carry important implications for tourism education globally, particularly regarding the enhancement of learners' competencies through AI integration. The positive impact of AI exposure on digital creativity underscores the potential for AI-driven tools to enrich curricula by cultivating students' abilities to generate innovative digital content—a critical skill as the tourism sector undergoes digital transformation worldwide.

However, the non-significant effect of AI exposure on problem-solving skills invites further reflection. This suggests that current AI applications may fall short in engaging students in complex, higher-order cognitive tasks requiring contextual judgment, creativity, and interpersonal skills—essential

for tackling multifaceted challenges like sustainable tourism, crisis management, and cultural sensitivity. This limitation is relevant globally but may be more pronounced in regions with unique socio-economic and cultural contexts, such as emerging tourism markets like Morocco. It highlights the necessity for pedagogical strategies that integrate AI with experiential, collaborative, and contextually grounded learning to foster active, real-world problem-solving engagement.

Therefore, educators and curriculum developers should aim for a balanced AI integration that supports digital creativity and critical thinking while intentionally developing problem-solving skills through interactive, practice-based learning. This holistic approach will better prepare tourism students worldwide for innovation-driven careers within a complex and dynamic global tourism environment.

4.4 Moderating effects

The findings of this study offer valuable insights into the relationships among digital creativity, critical thinking, problem-solving skills, absorptive capacity, and innovation capabilities in tourism students, especially in the context of AI exposure. While digital creativity, critical thinking, and problem-solving emerged as strong predictors of innovation capabilities regardless of AI experience, the moderating effect of AI experience on absorptive capacity reveals a more nuanced interplay that merits further consideration.

These results align with prior research highlighting the importance of cognitive and creative skills in driving innovation within tourism education (Gomezelj, 2016; Hjalager, 2010). This supports the continued emphasis on embedding these competencies within tourism curricula to equip students for a fast-evolving industry increasingly influenced by digital technologies (Samara *et al*., 2020).

While AI experience strengthens the link between absorptive capacity and innovation capabilities, this advantage is not equally accessible to all students. Recent research highlights significant disparities in AI and digital resource access, particularly between urban and rural students or those from economically disadvantaged backgrounds (Biriescu and Olteanu, 2025). These inequities risk widening gaps in skill development and innovation potential, presenting a critical challenge for educators and policymakers committed to equitable education. Without targeted support, students lacking sufficient AI exposure may lag behind, undermining inclusive innovation growth in tourism education.

Additionally, although AI tools can enhance absorptive capacity by improving data analysis, market insights, and ideation (Samara *et al*., 2020), there is increasing concern about cautious AI integration in education. Some educators warn that overreliance on AI might reduce essential human interactions that foster ethical, scientific, and interpersonal values fundamental to learning (El-Akhras *et al*., 2025). This tension underscores the need for balanced pedagogical approaches that harness AI to personalize and enrich learning (Biriescu and Olteanu, 2025) while maintaining the indispensable human elements of education.

This study contributes to a nuanced understanding that AI's role in tourism education is double-edged: while it can significantly enhance students' innovation capabilities, it also risks exacerbating educational disparities and ethical challenges if not carefully managed. Future research should focus on strategies to democratize AI access and develop educator training programs that promote constructive AI integration, ensuring that humanistic educational values are preserved (Knani *et al*., 2022).

5. Conclusion

This study offers several key contributions to understanding how AI exposure influences innovation capabilities among tourism students. First, it uniquely demonstrates that AI enhances innovation primarily through boosting digital creativity and absorptive capacity, rather than

directly improving problem-solving skills. This distinction clarifies that AI's benefits are stronger in fostering creative idea generation and effective knowledge acquisition and application.

Second, the research highlights the mediating roles of digital creativity and absorptive capacity in linking AI exposure to innovation, emphasizing these competencies as vital pathways through which AI drives innovation in tourism education. Additionally, the study identifies a moderating effect of AI experience on the absorptive capacity–innovation relationship, revealing a nuanced, conditional dynamic that enriches existing theoretical models.

Third, by focusing specifically on tourism students, the study contextualizes AI's impact within a sector undergoing rapid digital transformation, offering actionable insights for educators aiming to develop innovation-ready graduates. It underscores the importance of tailored educational strategies that harness AI to enhance creativity and knowledge use while acknowledging AI's limited influence on problem-solving.

Together, these contributions deepen the literature by providing a granular understanding of AI's role in cultivating key cognitive skills essential for innovation in tourism. They lay the groundwork for future research to explore underlying mechanisms, boundary conditions, and broader cognitive domains, guiding more effective AI integration in tourism education and supporting the sector's ongoing digital evolution.

6. Implications

6.1 Theoretical implications

This study enriches theoretical discourse on AI integration in tourism education by revealing differentiated effects of AI exposure across cognitive domains. The finding that AI exposure does not significantly enhance problem-solving—and that problem-solving negatively relates to innovation—challenges prevailing models that assume uniform cognitive benefits from AI (e.g. Skavronskaya *et al*., 2023). Instead, the results highlight AI as a multifaceted tool whose impact depends on context, targeted skills, and pedagogical design.

This calls for expanding existing frameworks to incorporate nuanced mechanisms recognizing varied cognitive pathways and potential unintended effects, such as cognitive offloading or reduced higher-order reasoning due to AI reliance (Hou *et al*., 2025). The identification of digital creativity and absorptive capacity as key mediators introduces new constructs for theoretical exploration, particularly their relationships with AI literacy and experiential learning. Future models should integrate both technological and human factors to better capture the complexity of innovation in tourism education. Finally, the moderating role of prior AI experience underscores individual differences in technology use, suggesting that personalized, learner-centered approaches are essential to fully harness AI's educational potential.

6.2 Practical implications

The findings emphasize the need for tourism educators to strategically integrate AI tools into curricula to boost students' digital creativity, absorptive capacity, and critical thinking. Educators can incorporate AI-driven applications such as chatbots and virtual assistants into practical coursework to simulate real-world customer service interactions and develop relevant problem-solving skills. Using AI-powered data analytics platforms for assignments enables students to analyze consumer behavior and market trends, promoting applied learning and innovation.

Interactive learning methods like AI-facilitated simulation and negotiation games further encourage collaboration, strategic decision-making, and critical reflection. For instance, teams of students can use AI chatbots to negotiate tourism service scenarios, fostering creativity and adaptive thinking in a dynamic environment. These experiential approaches conform with pedagogical best practices that emphasize active learning and engagement.

To maximize these benefits, educators need targeted professional development to enhance competence in AI technologies and teaching strategies that promote critical evaluation of AI outputs. Addressing disparities in AI access is also crucial; blended learning models combining digital and offline resources can ensure equitable opportunities for students from diverse socio-economic backgrounds.

Finally, collaboration among academic institutions, industry, and policymakers is essential to align curricula with technological advancements and ethical standards. Such partnerships can facilitate the integration of AI competencies that improve graduate employability and support sustainable digital transformation in the tourism sector.

7. Limitations and future directions

This study highlights AI's potential to enhance creativity, critical thinking, and knowledge utilization among tourism students but identifies several limitations needing further exploration. First, AI exposure did not directly improve problem-solving skills, indicating the need for complementary pedagogical activities to develop this competency. Second, responsible AI integration is essential, requiring educators to acknowledge tool limitations, potential biases, and provide guidance on ethical AI use. Third, the study focused on general AI exposure rather than specific applications; future research should investigate the effectiveness of different AI tools within tourism education.

A key limitation is the reliance on self-reported data, which may be affected by biases such as social desirability and recall inaccuracies (Brutus *et al*., 2013), potentially impacting the validity and reliability of findings on creativity, critical thinking, and knowledge use. Future studies would benefit from incorporating objective assessments like behavioral tasks or performance-based evaluations to triangulate and strengthen evidence.

The study lays groundwork for understanding AI's role in tourism education, suggesting several future research avenues. These include examining the long-term effects of AI exposure as students advance academically and professionally, evaluating the effectiveness of specific AI-based learning activities in fostering problem-solving alongside creativity and knowledge use, and exploring AI's role in enhancing interdisciplinary collaboration and teamwork. Additionally, developing frameworks for responsible AI integration that address ethics, data privacy, and impacts on human skills is crucial. Comparative studies across programs and institutions will also be valuable to identify best practices and challenges for effectively and responsibly embedding AI in tourism education.

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Data availability

Data can be made available upon request.

Supplementary material
The supplementary material for this article can be found online.

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