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Teachers' attitudes and behavioural intentions towards AI integration in Chinese higher education: a qualitative interview study

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Introduction: The rapid expansion of generative AI has intensified scholarly and policy debate over its role in higher education, yet university teachers' attitudes towards its integration remain complex and context-dependent. This study explores how university teachers perceive, experience, and respond to AI integration in their teaching. Guided primarily by the three-component attitude model and informed by the technology acceptance model and the theory of planned behaviour, the study examines cognitive appraisals, affective responses, behavioural intentions, and perceived support needs.

Methods: The study draws on semi-structured interviews with 14 university teachers from four higher education institutions in China. The interview data were analysed using codebook-informed thematic analysis combining deductive and inductive coding.

Results: The findings indicate that teachers generally perceive AI as a supportive rather than substitutive educational tool, valuing it for improving efficiency, supporting lesson preparation, and enriching pedagogical design. Emotional responses varied from enthusiasm and a sense of accomplishment to caution, neutrality, and, in some cases, declining satisfaction. Across the interviews, teachers' primary concerns centred less on their own replacement than on the perceived risks of inappropriate AI use for students' independent thinking, reasoning, originality, and authentic understanding. Teachers' intentions to adopt AI were therefore conditional and bounded, shaped by pedagogical purpose, disciplinary context, student readiness, and the need to maintain teacher control. Teachers also emphasised that sustainable AI integration requires more than general encouragement, calling instead for AI literacy development, discipline-sensitive support, specialised tools, and enabling institutional infrastructure.

Discussion: Overall, these findings extend contextual understandings of teachers' AI acceptance by showing how adoption intentions are pedagogically negotiated and highlight the importance of supporting professional judgement and students' independent thinking in higher education.

KEYWORDS
AI integration, AI literacy, generative artificial intelligence, higher education teachers, student development, teachers' attitudes

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1 Introduction

The increasing adoption of artificial intelligence (AI) across sectors has begun to transform higher education by reshaping pedagogical approaches, administrative processes, and student learning experiences (Al-Mughairi and Bhaskar, 2024; Zhao et al., 2025). AI has the potential to influence educational systems through its effects on teachers' pedagogical knowledge, course design practices, content delivery, and instructional methods, although the extent of this influence remains context-dependent (Ren and Wu, 2025). At the same time, concerns about academic integrity, students' cognitive engagement, and the responsible use of AI have raised important questions about how these technologies should be integrated into teaching (Bittle and El-Gayar, 2025; Zhai et al., 2024). Understanding how university teachers evaluate these opportunities and challenges is therefore important for informing appropriate AI integration in higher education.

University teachers play a central role in determining how AI is adopted and used in educational practice. Existing research has identified AI literacy, perceived technological benefits, pedagogical suitability, and institutional support as important considerations in teachers' acceptance of AI (Al-Abdullatif, 2024; Ofosu-Ampong, 2024). Furthermore, Verano-Tacoronte et al. (2025) found that teachers' anxiety about AI's potential effects on student learning was negatively associated with their intentions to adopt ChatGPT. These findings indicate that teachers' responses to AI involve cognitive evaluations, emotional concerns, and behavioural intentions, alongside broader contextual conditions. However, identifying factors associated with acceptance does not fully explain how teachers interpret these considerations together or negotiate their use of AI in specific teaching contexts.

Despite growing research on teachers' perceptions of AI, further qualitative investigation is needed to understand how cognitive appraisals, affective responses, and behavioural intentions are interconnected within teachers' pedagogical experiences. Guided primarily by the three-component attitude model (Rosenberg and Hovland, 1960), and informed by the technology acceptance model (TAM) and the theory of planned behaviour (TPB), the present study examines these dimensions in the context of Chinese higher education. Specifically, the study explores university teachers' perceived benefits and challenges of AI integration, their emotional responses, how these considerations relate to their reported adoption intentions, and the support structures they consider necessary for effective and ethical AI use. By examining these dimensions together, the study aims to provide a contextualised understanding of teachers' attitudes towards AI integration and their implications for higher education teaching practice.

Accordingly, the study is guided by the following research questions:

1 What are university teachers' cognitive appraisals (for example, perceived benefits and challenges) regarding AI integration in higher education?
2 What affective responses (e.g., excitement, anxiety, curiosity) do university teachers report regarding AI integration in their teaching?
3 How do teachers' cognitive appraisals and affective responses interact to shape their behavioural intentions to adopt or resist AI tools in teaching?
4 What support structures and resources (e.g., training, policy guidance, infrastructure) do university teachers consider necessary for effective and ethical AI integration in higher education?

Abbreviations: AI, Artificial intelligence; TAM, the technology acceptance model; TPB, the theory of planned behaviour.

2 Literature review

2.1 The evolving landscape of AI in education

Artificial intelligence (AI), particularly in its generative forms, has attracted growing attention in higher education for its potential to support teaching, learning, assessment, and administrative work (Hughes et al., 2025; Kotsis, 2025). Reviewing earlier research on AI in higher education, Crompton and Burke (2023) documented diverse applications, including intelligent tutoring, assessment, and learning management. However, Bond et al. (2024) highlighted the continued need for greater methodological rigour, ethical consideration, and contextual sensitivity in AI-related educational research. Together, these reviews suggest that the expanding use of AI does not necessarily establish its pedagogical value across different educational settings.

Existing research has identified several potential benefits of AI integration, including support for instructional design, personalised learning, and administrative efficiency. Ren and Wu (2025), for example, highlighted AI-related teaching competencies and opportunities for pedagogical innovation, whilst also identifying technical limitations, digital divides, and ethical challenges. Studies of adaptive learning systems have reported opportunities for tailoring instructional content to students' needs (Hariyanto et al., 2025), whereas research on administrative applications has examined potential improvements in operational efficiency (Suazo-Galdamés and Chaple-Gil, 2025). However, these benefits concern different educational functions and outcomes. Greater efficiency or technological capability does not necessarily translate into improved learning or pedagogical effectiveness. Whether AI is considered useful therefore also depends on how its capabilities align with particular teaching purposes and disciplinary requirements.

Alongside these potential benefits, researchers have raised concerns about the educational and ethical implications of AI integration. Zhai et al. (2024) reviewed the potential consequences of overreliance on AI dialogue systems for students' cognitive abilities, whilst Bittle and El-Gayar (2025) examined challenges to academic integrity associated with generative AI. Al-Zahrani and Alasmari (2024) further highlighted ethical, social, and educational considerations, including concerns about privacy and responsible implementation. Although these studies identify important risks, their findings should not be interpreted as evidence that all forms of AI use necessarily undermine learning. Rather, they raise questions about the conditions under which AI supports or potentially displaces meaningful cognitive engagement. Such concerns are particularly relevant to teachers, who

must consider not only what AI can accomplish, but also whether and how its use aligns with their educational responsibilities.

Research on teachers' acceptance of AI provides further insight into these considerations. Al-Abdullatif (2024) found that AI literacy and perceived ease of use were significant predictors of generative AI acceptance amongst university teachers, whereas perceived usefulness did not show a significant direct effect in the tested model. Similarly, Ofosu-Ampong (2024) identified teaching experience, institutional support, and perceived pedagogical affordances as factors associated with university teachers' AI acceptance. Moving beyond instrumental evaluations, Verano-Tacoronte et al. (2025) found that university teachers' anxiety about AI's potential effects on student learning was negatively associated with their intentions to adopt ChatGPT. These findings suggest that teachers' acceptance involves not only perceived technological benefits, but also emotional responses, pedagogical concerns, and contextual conditions. However, studies primarily examining statistical associations offer less insight into how teachers themselves interpret these considerations, negotiate competing priorities, and establish boundaries for AI use in specific teaching contexts. Understanding these processes calls for closer examination of teachers' cognitive appraisals, affective responses, behavioural intentions, and perceived support needs, which informs the theoretical discussion that follows.

2.2 Theoretical foundations: understanding technology acceptance and attitudes

Understanding teachers' acceptance of emerging technologies requires consideration of both technology-related evaluations and broader psychological processes. Two influential frameworks in this area are the technology acceptance model (TAM) and the theory of planned behaviour (TPB). TAM proposes that an individual's intention to use technology is primarily shaped by their perceived usefulness (the belief that using the technology will enhance performance) and perceived ease of use (the belief that using the technology will be free of effort) (Davis et al., 1989). Scherer et al. (2019) demonstrated the relevance of TAM to teachers' adoption of digital technologies in educational settings. However, understanding AI integration in higher education also requires consideration of how teachers evaluate technological benefits in relation to their specific pedagogical responsibilities and teaching contexts.

TPB complements this perspective by proposing that behavioural intentions are influenced by attitudes towards the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991). This framework has been applied to educational technology adoption, including studies involving teachers and pre-service teachers (Hamad et al., 2024; M. Hou et al., 2022). Together, TAM and TPB provide useful explanations of factors associated with technology acceptance and adoption intentions. However, research applying these models has often focused on identifying predictors of acceptance, offering less insight into how teachers interpret and negotiate the cognitive, emotional, and pedagogical considerations underlying their decisions. A more differentiated examination of attitude components may therefore complement these established approaches.

To examine these dimensions, the present study draws primarily on the three-component, or tripartite, model of attitude. This model distinguishes cognitive, affective, and behavioural components (Rosenberg and Hovland, 1960; Triandis, 1964). Breckler (1984) provided empirical support for this distinction whilst also demonstrating that the components are related rather than entirely independent. Accordingly, the three components are treated in this study as analytically distinguishable but potentially interconnected dimensions of teachers' attitudes towards AI.

Cognitive Component: This dimension refers to an individual's beliefs, thoughts, knowledge, and perceptions about the attitude object. In the context of AI integration in higher education, this dimension includes educators' beliefs about AI's capabilities, potential benefits (e.g., efficiency, personalisation), and risks (e.g., ethical concerns, job displacement).

Affective Component: This component encompasses the feelings and emotional responses an individual experiences in relation to the attitude object. For educators, this may manifest as excitement, enthusiasm, anxiety, fear, or frustration regarding AI tools and their integration into teaching practices. Affective reactions are widely recognised as a central component of attitude formation.

Behavioural Component: This dimension refers to an individual's predisposition or intention to act towards the attitude object, reflecting the translation of beliefs and emotional responses into context-dependent behavioural intentions.

These three dimensions provide a framework for examining teachers' attitudes without assuming that favourable cognitive evaluations necessarily produce positive emotions or unconditional adoption intentions. Teachers may recognise AI's practical usefulness whilst expressing concerns about its educational implications, and such considerations may inform their willingness to adopt AI selectively. The tripartite model therefore complements TAM and TPB by supporting a closer examination of how evaluations, emotional responses, and reported behavioural intentions are understood and negotiated within particular pedagogical contexts.

Although existing technology acceptance research has identified important factors associated with teachers' adoption of AI, further qualitative investigation can illuminate how these considerations interact in teachers' own accounts. The present study addresses this need by examining university teachers' cognitive appraisals (RQ1), affective responses (RQ2), and how these dimensions relate to their reported behavioural intentions (RQ3). It also explores the institutional support and resources teachers consider necessary for meaningful AI integration (RQ4). Together, these perspectives provide a theoretically informed basis for understanding AI acceptance as a context-dependent and pedagogically negotiated process.

3 Methods

3.1 Participants and sampling

This study employed purposive sampling to recruit university teachers from four higher education institutions in China. Purposive sampling was used because the study aimed to explore information-rich accounts from teachers who had direct experience of, or informed views on, the integration of AI into higher education teaching. The participating institutions were identified through the research team's professional and institutional networks. They were selected because they provided access to teachers from different disciplinary areas,

academic ranks, and levels of teaching experience, which was appropriate for exploring diverse perspectives on AI integration in higher education.

Potential participants were initially identified through institutional contacts and professional networks. When recommending potential participants, institutional contacts provided information about their teaching areas, academic ranks, and AI-related experience. This information informed the research team's assessment of their suitability for inclusion and helped achieve variation in the sample. They were considered suitable for inclusion if they were academic staff in Chinese higher education institutions with ongoing or recent teaching responsibilities, including those whose teaching duties varied by semester, and if they were able to reflect on the use, potential use, or implications of AI in teaching and learning.

A total of 14 university teachers agreed to participate and completed interviews. The final sample included 6 female and 8 male participants. Gender was not used as a formal selection criterion but is reported to describe the sample. Participants varied in disciplinary background, academic rank, and teaching experience, including teachers from mental health education, ideological and political education, education, digital media art, programming, engineering, and financial management. The sample size was considered appropriate for the aims of the study because the interviews generated sufficient conceptual depth across the four research questions, and later interviews largely

TABLE 1 Participant characteristics.

Participant	Gender	Discipline/teaching area	Academic rank	Years of teaching experience
P001	Male	Mental health education/public compulsory course	Lecturer	Less than 1 year
P002	Male	Mental health education/public compulsory course	Lecturer	Approximately 2 weeks
P003	Female	Programming/software development/technical courses	Lecturer	10 years
P004	Female	Mental health education/public compulsory course	Lecturer	3–4 months
P005	Male	Visual interface design/VR/Unity3D/professional course	Lecturer	2 years
P006	Male	Ideological and political education/philosophy/humanities and social sciences	Professor	Approximately 10 years
P007	Male	Digital media art/AI-generated image and design-related courses	Associate Professor	18 years
P008	Female	Ideological and political education	Lecturer	13 years
P009	Male	Financial management/professional course	Lecturer	Less than 6 months
P010	Female	Senior academic administrator with university teaching responsibilities	Professor	30 years
P011	Female	Education/Foundations of Education	Associate Research Fellow	Approximately 17–18 years
P012	Female	Ideological and political education/humanities and social sciences	Associate Professor	12 years
P013	Male	Engineering/technical courses: engineering mechanics, railway bridge construction and maintenance	Senior Engineer	8 years
P014	Male	Mental health education/general education	Associate Professor	13 years

Participant information is reported at a broad descriptive level to preserve anonymity. Institutional names are not provided. P010 had no teaching assignment during the semester in which the interview was conducted, but she normally undertakes teaching responsibilities in other semesters and provided both a senior teaching and institutional perspective on AI integration in higher education.

reinforced rather than substantially changed the emerging thematic structure. A summary of participant characteristics is provided in Table 1.

3.2 Data collection

Semi-structured interviews were conducted by the research team to explore university teachers' attitudes towards AI integration in higher education. This approach enabled a flexible yet focused inquiry into participants' attitudes, behavioural intentions, experiences, and pedagogical adaptations (Creswell and Poth, 2018). Semi-structured interviews allowed the research team to use a consistent interview protocol whilst also giving participants sufficient flexibility to elaborate on issues that were particularly salient in their own teaching contexts. As the research questions focused on teachers' subjective evaluations, emotional experiences, reported adoption intentions, and perceived support needs, semi-structured interviews were considered appropriate for obtaining detailed, context-sensitive accounts of these dimensions. Additional observational data were not collected, as the study did not seek to independently assess classroom practices or student learning outcomes.

Each interview lasted approximately 40–60 min and was conducted either in person or online, depending on participants' availability. A standardised interview protocol was developed and consistently applied to ensure comparability across all interview sessions. Questions were organised around four key domains (i.e., cognitive, affective, behavioural, and support-related) that directly addressed the study's objectives. All interviews were audio-recorded with participants' informed consent and subsequently transcribed verbatim to facilitate accurate and comprehensive analysis.

3.3 Data analysis

The interview data were analysed using a codebook-informed thematic analysis combining deductive and inductive coding. Thematic analysis was appropriate because the study aimed to identify patterned meanings across participants' accounts whilst retaining sensitivity to the complexity of teachers' experiences and interpretations (Braun and Clarke, 2022). A codebook-informed approach was adopted because the study was guided by established theoretical constructs whilst also allowing themes to be developed through close engagement with the data (Roberts et al., 2019). This approach was therefore suitable for combining deductive and inductive coding within a single analytic process (Fereday and Muir-Cochrane, 2006).

Deductive coding was guided by the study's theoretical and conceptual foundations, particularly key constructs derived from the three-component structure of attitudes, TAM, and TPB, as outlined in the literature review. These concepts served as sensitising lenses for the initial organisation of the data rather than as rigid predetermined categories. Concurrently, inductive coding was used to capture patterns and meanings emerging directly from participants' accounts, enabling the identification of themes that extended beyond the initial theoretical framework and allowing novel insights to emerge (Fereday and Muir-Cochrane, 2006).

The analysis followed an iterative process. First, the research team familiarised themselves with the interview transcripts through repeated reading. Second, preliminary codes were generated using ATLAS.ti, guided by both the theoretical framework and the interview data. Third, the research team developed and refined a shared codebook through analytic discussion. The purpose of this process was not to calculate statistical intercoder reliability, but to improve conceptual clarity, coding consistency, and transparency in the interpretation of the data. Fourth, codes were grouped into candidate themes and reviewed against both individual extracts and the full dataset. Fifth, the themes were refined, named, and organised in relation to the research questions.

Three researchers were involved in the coding and analytic discussion process. Their discussions focused on comparing interpretations, refining code definitions, and ensuring that the developing themes were coherent and well supported by the data. In addition, an independent researcher was invited through the research team's academic collaboration network based on their expertise in qualitative research. The researcher reviewed a subset of the coded data and the developing thematic structure. This independent review was used as a credibility check to identify possible ambiguities, assess whether the themes were adequately grounded in the data, and support the trustworthiness of the analysis (Nowell et al., 2017). The coding framework was refined through movement between individual extracts, complete transcripts, and the developing themes until sufficient conceptual depth was reached and no substantially new interpretive patterns emerged (Ando et al., 2014).

Illustrative quotations were translated from Chinese into English by the research team for reporting purposes. The translations were checked against the original Chinese transcripts to ensure that the meanings of participants' accounts were preserved.

3.4 Ethical considerations

Ethical approval for this study was obtained (Ref. SMEA20250601). All participants were provided with a comprehensive information sheet outlining the study's purpose, procedures, and their rights, and they subsequently provided informed consent prior to participation. Participants were explicitly informed of their right to withdraw from the study at any point without penalty and were assured of the confidentiality and anonymisation of their responses, with all identifying information removed from transcripts.

4 Results

Analysis of 14 interviews generated five interrelated themes concerning teachers' perceptions, emotional responses, behavioural intentions, and support needs related to AI integration in higher education: (1) support rather than substitution, (2) differentiated emotional responses, (3) students at the centre of teachers' concerns, (4) conditional and bounded adoption, and (5) beyond generic support. Overall, teachers' attitudes towards AI were neither uniformly positive nor uniformly negative. Rather, they were shaped by perceived usefulness, disciplinary context, student-related concerns, professional judgement, and institutional conditions.

Theme 1 primarily addresses RQ1 by examining teachers' cognitive appraisals of AI integration, whilst Theme 2 addresses RQ2 through their affective responses. Themes 3 and 4 jointly inform RQ3 by showing how concerns about students' learning, alongside

perceived benefits and emotional experiences, relate to teachers' conditional adoption intentions. Theme 5 addresses RQ4 by identifying the support structures and resources considered necessary for meaningful AI integration.

4.1 Support rather than substitution

Teachers generally perceived AI as a supportive rather than substitutive educational tool. Across the interviews, AI was rarely framed as something that could replace teachers. Instead, participants more often described it as a practical assistant that could improve efficiency, extend pedagogical thinking, and facilitate teaching-related tasks. However, this supportive role was seen as highly dependent on discipline, task type, and context.

4.1.1 Efficiency and pedagogical support

The most immediate and widely shared perception of AI concerned its usefulness in reducing workload and increasing efficiency. Teachers commonly reported using AI for lesson preparation, material retrieval, wording refinement, routine writing, and presentation design. As one participant put it, AI was "very convenient… greatly improving efficiency and saving time" (Participant 008). Another explained that AI made lesson preparation "much easier" because it helped transform difficult textbook content into more accessible teaching materials (Participant 009).

Participants also described AI as a source of pedagogical support. Several teachers reported using AI to generate cases, improve transitions, refine language, and structure lessons. One participant noted, "I ask it to help design the framework of the PPT, but the flesh and blood are still filled in by me" (Participant 001), highlighting that AI was valued as a scaffold rather than an autonomous creator. Another teacher similarly remarked that AI had "completely opened up my thinking" in course design (Participant 002). Thus, AI was appreciated not only for saving time, but also for extending teachers' existing ideas and making preparation more flexible.

4.1.2 Discipline- and task-sensitive usefulness

Although participants broadly acknowledged AI's usefulness, they rarely regarded it as equally valuable across all teaching contexts. Instead, they evaluated AI in relation to the knowledge demands, task complexity, and educational aims of their own disciplines. In design-related fields, AI was associated with idea generation, visual experimentation, and creative expansion. In contrast, teachers in engineering and technical disciplines emphasised accuracy, precision, and reliability. One engineering teacher argued that AI-generated content should be treated as "information" rather than "knowledge," because it could not automatically be assumed to be correct without professional checking (Participant 013).

A similar pattern appeared in ideological and political education, where participants stressed that generic AI tools might produce content that was inaccurate or insufficiently aligned with disciplinary and value-oriented requirements. One participant therefore called for more discipline-specific AI support in this area (Participant 012). These accounts suggest that teachers did not judge AI in abstract terms; rather, they assessed it according to whether it aligned with the specific demands of their teaching contexts.

4.1.3 Support, not replacement

Despite differences in discipline and task type, a consistent pattern emerged across the interviews: teachers positioned AI as supportive but not substitutive. Even highly positive participants insisted that it should remain secondary to human judgement, pedagogical intention, and teacher control. One teacher stated that AI was "only playing an auxiliary role" (Participant 002), whilst another summarised the preferred relationship as "human-led, with AI as support" (Participant 004). In a more direct formulation, one participant remarked, "I use AI; AI does not use me" (Participant 001).

This emphasis on human control also appeared in metaphorical language. One participant argued that AI could function as "a secretary," but "it cannot lead us" (Participant 014), whilst another insisted that "the core, the absolute core, is still your own thinking" (Participant 007). Taken together, these accounts show that teachers' endorsement of AI was not an endorsement of replacement, but of bounded support under continued human direction.

4.2 Differentiated emotional responses

Teachers' emotional responses to AI were far from uniform. Whilst many participants described generally positive reactions, these varied in intensity and were often accompanied by caution, frustration, or anxiety. Across the interviews, three broad patterns emerged: enthusiasm and achievement, cautious positivity, and emotionally neutral pragmatism. In a few cases, participants also described a shift from initial appreciation to later dissatisfaction.

4.2.1 Enthusiasm, achievement, and curiosity

For a substantial group of participants, AI elicited positive emotions, particularly excitement, curiosity, and a sense of achievement. These emotions were often linked to moments when AI improved efficiency, generated useful ideas, or helped them overcome difficult tasks. One participant recalled feeling "excited" when AI helped him understand teaching content more quickly and made lesson preparation easier (Participant 009). Another described her overall response to increased AI use in teaching and daily life simply as "welcome" (Participant 012).

Positive emotions were also linked to experiences of cognitive stimulation. One participant described AI as producing "resonance" and "sparks" during lesson preparation (Participant 012), whilst another noted that AI had "completely opened up my thinking" in teaching design (Participant 002). In some cases, the emotional significance of AI went beyond convenience. One teacher explained that AI had helped him during a particularly difficult phase of doctoral writing, effectively "pulling him through" a challenging task (Participant 009). These accounts suggest that teachers' positive emotions reflected not

only efficiency, but also relief, inspiration, and in some cases, increased confidence.

4.2.2 Cautious positivity and control anxiety

At the same time, positive feelings were often accompanied by caution. Many teachers accepted AI as useful, but remained uneasy about overreliance, inappropriate outputs, or a loss of control over teaching and thinking. One participant noted that although she had a sense of achievement when using AI, she also experienced "anxiety" and "a very obvious feeling of losing control" when AI-generated interpretations began to take her in directions she had not intended (Participant 012). Likewise, another teacher working in a creative discipline described how AI could "lead your thinking away," requiring him to return repeatedly to his original prompt and reorient the task (Participant 007).

For some participants, caution was directed less at themselves than at the educational consequences of AI. Teachers who were broadly enthusiastic still expressed concern that AI might weaken students' thinking, encourage passivity, or distort classroom purposes. Thus, positive emotional engagement did not imply unconditional confidence; rather, many participants combined optimism with a strong awareness that AI use required monitoring and boundary-setting.

4.2.3 Emotional neutrality and pragmatic detachment

Not all participants responded to AI with enthusiasm or anxiety. A smaller but important group described their emotional stance as neutral, routine, or natural. For these teachers, AI was not experienced as a disruptive innovation but as one more practical work tool. One participant stated that using AI felt "very natural," adding that it had become "just a tool" like other technologies used in academic work (Participant 010). Another repeatedly emphasised that he had "no particular feeling" about AI in teaching and used it mainly when it was pragmatically useful (Participant 006).

This emotionally neutral stance was often associated with lower expectations. Rather than seeing AI as exciting or transformative, these teachers tended to view it instrumentally and selectively. This pattern is important because it shows that teachers' emotional responses to AI were not reducible to positive or negative reactions alone; emotional detachment was also a meaningful position within the dataset.

4.2.4 Declining satisfaction over time

A further pattern, though less common, involved a shift from initial appreciation to later dissatisfaction. One participant described her early experience of AI as helpful and time-saving, noting that it had initially felt "quite good" because it reduced unnecessary effort (Participant 011). However, she later became less satisfied, explaining that repeated use produced formulaic outputs that no longer met her expectations. As she put it, after a while AI seemed to generate "the same routines again and again," which led her to reduce her dependence on it (Participant 011).

This pattern suggests that emotional responses to AI can evolve with use. Early efficiency gains may generate strong positive reactions, but these can weaken if AI outputs begin to feel repetitive, shallow, or insufficiently tailored.

4.3 Students at the centre of teachers' concerns

Across the interviews, teachers' strongest concerns centred not on their own replacement by AI, but on students' problematic use of AI. Whilst most participants acknowledged that AI could support learning in some circumstances, they repeatedly warned that students might use it in ways that could weaken independent thinking, logical reasoning, originality, and authentic understanding. Student-related concerns therefore formed the most consistent area of tension in an otherwise broadly positive set of attitudes towards AI. These findings reflect teachers' perceptions and reported experiences rather than independently verified changes in students' learning or cognitive abilities.

4.3.1 Outsourcing of thinking and reasoning

The most common concern was that students would use AI to bypass the thinking process rather than support it. Teachers worried that students might move too quickly from encountering a task to seeking an AI-generated answer, without engaging in analysis, reasoning, or reflection. One participant stated that the most serious issue was that students were "handing over the process of thinking to AI" (Participant 003). Similarly, another teacher observed that students often used AI "just to see the answer and complete the task, but they do not think about it" (Participant 009).

This concern was especially strong in courses requiring foundational understanding or step-by-step reasoning. In technical and quantitative contexts, teachers stressed that students might preserve the final result whilst losing the logical chain needed to understand how that result had been derived. For these participants, the danger of AI was not simply that students used it, but that they used it to avoid cognitive effort.

4.3.2 Weak discrimination and overtrust in AI outputs

A second major concern was students' limited ability to judge the quality of AI-generated content. Participants repeatedly noted that students were often insufficiently equipped to tell whether AI outputs were accurate, relevant, or appropriate. One teacher warned that students might not be able to "identify whether it is right or wrong" and could easily be "confined" by what AI produced (Participant 004). Another participant similarly argued that many students lacked the ability to determine "whether the AI-generated content is actually good or bad" (Participant 005).

Teachers viewed this as a serious educational issue because overtrust in AI could lead students to accept plausible but flawed answers

without verification. In some fields, this meant accepting inaccurate or poorly fitted examples; in others, it meant trusting calculations, interpretations, or arguments that were not actually reliable. Students were therefore seen as needing not only access to AI, but also the critical capacity to question, verify, and selectively use what it produced.

4.3.3 Superficial task completion without genuine understanding

Many teachers also distinguished between completing a task and genuinely understanding it. They observed that AI could help students produce polished-looking outputs without necessarily improving comprehension, explanation, or communication. One participant gave a particularly clear example, noting that students' PowerPoint presentations could look "very well done," but when they actually delivered the presentation, "it was not very good" (Participant 011). In her view, AI had improved the appearance of performance without strengthening the underlying understanding.

A similar pattern appeared in participants' discussions of assignments and classroom exercises. Students could use AI to generate answers, reports, or written products that met surface requirements, yet still fail to grasp the concepts, arguments, or reasoning involved. In some cases, teachers worried that this would create a misleading sense of competence.

4.3.4 Erosion of originality, criticality, and authenticity

In creative, design-oriented, and writing-intensive contexts, teachers placed particular emphasis on originality, authenticity, and criticality. They worried that students might rely on AI-generated ideas, visuals, or wording in ways that reduced their own creative contribution. One design teacher warned that students could become overly dependent on AI and gradually lose "their own ideas" (Participant 005). Another participant expressed concern that students might produce increasingly homogeneous work because AI-generated outputs often pushed them towards similar patterns and solutions (Participant 007).

These concerns also extended to authenticity and academic honesty. Teachers described situations in which AI-generated answers were copied directly into assignments, creating work that was uniform, detached from course expectations, and poorly aligned with what students had actually learned. For these participants, the issue was not merely plagiarism in a formal sense, but a broader weakening of authentic intellectual engagement.

4.3.5 False confidence and weak educational use of AI

A further layer of concern involved the possibility that AI might reduce students' anxiety or help them complete tasks more easily without producing genuine cognitive growth. One participant working in a higher vocational context argued that AI could lower students' fear of difficult tasks and increase their willingness to begin, but she also questioned whether this might create "a false sense of achievement, or false prosperity" (Participant 008). This observation suggests that teachers did not automatically interpret student comfort or confidence as evidence of meaningful learning.

At the same time, some teachers noted that the problem was not always overuse. In certain contexts, especially amongst higher vocational students, the issue was that many students did not yet know how to use AI meaningfully for learning at all. One participant remarked that most students were more likely to use AI to solve everyday life problems than to support deeper academic study (Participant 012). Student-related concerns therefore took at least two forms: excessive dependence and underdeveloped educational use.

4.4 Conditional and bounded adoption

Teachers' accounts suggested that cognitive appraisals and affective responses jointly informed their intentions to adopt AI selectively rather than unconditionally. Perceived efficiency and pedagogical value often encouraged AI use, but concerns about student dependence and the preservation of teacher control led participants to favour clearer boundaries. Conversely, disappointing experiences with AI-generated outputs could weaken initial satisfaction and reduce willingness to rely on these tools. Thus, teachers' reported adoption intentions reflected a balancing of practical benefits, emotional experiences, student readiness, and professional judgement, rather than straightforward acceptance or rejection.

4.4.1 Need-based and selective use

A recurring pattern across the interviews was that teachers used AI when it served a clear purpose, but did not feel compelled to use it in every aspect of teaching. One participant stated that she would use AI "when needed," but not as a matter of habit (Participant 004). Similarly, another participant explained that his use was shaped by immediate utility: if AI could genuinely solve a problem, he would use it, but if not, there was no reason to force it into practice (Participant 006).

This need-based logic helps explain why broadly positive attitudes did not always translate into high-frequency or visible classroom use. For many teachers, adoption was pragmatic rather than ideological. AI was treated as one option amongst many, and its inclusion depended on whether it offered a meaningful gain in a given situation.

4.4.2 Human thinking first, AI as subsequent support

Another highly consistent pattern was the insistence that human thinking should come first, with AI entering only as a secondary support. Teachers repeatedly stressed that students should first attempt to think, analyse, or respond on their own before consulting AI. One participant put this very clearly: "I do not stop them from using AI, but I first ask them to think by themselves" (Participant 009). In a similar vein, another teacher argued that AI should come "afterwards, as a supplement" rather than replacing students' own discussion or reflection from the start (Participant 004).

This sequencing principle was central to teachers' attempts to preserve student agency. Even amongst strong adopters, AI was rarely positioned as the starting point of learning. Instead, teachers tended to support a model in which AI followed, extended, or refined human thinking rather than pre-empting it.

4.4.3 Adoption shaped by course stage, task type, and student capability

Teachers also described AI as more suitable for some stages of teaching and learning than others. Many were more comfortable using AI in lesson preparation, assignment design, feedback preparation, or post-class support than in foundational stages of student learning. One participant teaching financial management argued that in basic courses students first needed to understand "why it is calculated in this way" before AI could be appropriately introduced (Participant 009). Another participant noted that AI was better suited to more advanced, integrative, or project-based tasks than to the earliest stages of skill formation (Participant 007).

Student capability further shaped these judgements. Teachers were generally more willing to encourage AI use when students were thought capable of checking, interpreting, or critically using the output. Where students were seen as likely to rely on AI blindly, teachers became more cautious.

4.4.4 Teacher control, professional identity, and pedagogical boundaries

For some participants, adoption was also shaped by a strong desire to preserve teacher control and pedagogical identity. One participant stated explicitly, "I control the class; I would not let AI control it" (Participant 006). Another insisted that even if AI could be helpful, it should remain "a secretary" rather than "a leader" (Participant 014). These expressions highlight that AI use was often evaluated not only in terms of efficiency or effectiveness, but also in relation to whether it threatened teachers' sense of authorship, direction, or responsibility in teaching.

This concern was particularly visible amongst participants who were sceptical of standardised or externally imposed AI solutions. For them, bounded adoption was a way of preserving pedagogical diversity and professional judgement.

4.4.5 Experience- and resource-responsive adoption

Finally, adoption was shaped by both prior experience and material conditions. Positive experiences often strengthened future willingness to use AI, whereas poor-quality outputs or repeated failures weakened trust. One participant explained that he was willing to continue paying for AI tools because they had repeatedly helped him solve real problems efficiently (Participant 009). By contrast, another participant reported becoming less dependent on AI after repeated disappointment with formulaic outputs that no longer met her expectations (Participant 011).

Resource conditions also mattered. Several teachers said they would use AI more frequently if there were better institutional resources, specialised models, clearer guidance, or stronger infrastructure. One participant explicitly stated that with more support and training, he would "probably use it more often" (Participant 009). Another argued that if curricular autonomy were greater, opportunities to use AI meaningfully would also increase (Participant 008). These accounts suggest that adoption could deepen, stagnate, or narrow depending on the interaction between teachers' experience, confidence, and the support environment around them.

4.5 Beyond generic support

Participants consistently argued that sustainable AI integration required more than broad encouragement or occasional introductory training. Although many acknowledged that schools and colleges had begun to provide lectures, workshops, or general policy support, these efforts were often seen as too generic, fragmented, or disconnected from teachers' actual needs. Across the interviews, teachers called for support that was more targeted, practical, discipline-sensitive, and sustainable.

4.5.1 Targeted and practice-oriented professional support

A highly consistent finding across the dataset was that teachers did not simply want more training; they wanted training that was directly relevant to their own teaching tasks, disciplinary contexts, and professional roles. One participant argued that the most useful support would be training that was "grounded" and practical rather than abstract or overly technical (Participant 001). Similarly, another participant said that what teachers most needed was not general discussion about AI, but demonstration-based support showing how it could be used in actual teaching situations (Participant 002).

This demand for relevance also extended to AI literacy and prompt literacy. Several participants stressed that many teachers were already using AI in a superficial or instinctive way, but had not developed the competence needed for higher-quality use. One participant explicitly distinguished between simply using AI to reduce workload and developing genuine AI literacy, arguing that widespread use should not be mistaken for meaningful competence (Participant 014). Another participant similarly emphasised that many teachers still lacked the ability to formulate effective prompts, even when they were willing to use AI (Participant 012).

4.5.2 Specialised tools and enabling infrastructure

Teachers also repeatedly stressed that generic AI tools were often insufficient for meaningful educational integration. Instead, many called for more specialised tools, trained models, discipline-specific resources, and better implementation infrastructure. One engineering teacher argued that the most valuable institutional support would be access to trained or "domesticated" models, because general-purpose AI often produced inaccurate or untrustworthy answers that required extensive reworking (Participant 013). Likewise, a participant in ideological and political education expressed a strong desire for an AI agent specifically designed for that field, so that generated outputs could draw on more accurate and value-appropriate materials (Participant 012).

In other cases, participants emphasised that even motivated teachers could not integrate AI meaningfully without suitable platforms, databases, or hardware. One teacher working in a higher vocational context argued that hardware and platform limitations were the biggest barriers to classroom use, especially when interactive or immersive applications were being considered (Participant 008). Another participant similarly warned that, without adequate platform development, many proposed AI applications would remain "castles in the air" rather than becoming workable teaching tools (Participant 014).

4.5.3 Support that respects pedagogical and disciplinary diversity

Although teachers broadly welcomed support, many also rejected standardised or one-size-fits-all solutions. They emphasised that higher education teaching varied too widely across disciplines, tasks, and pedagogical purposes for a single AI model or training approach to fit everyone. One senior participant stated directly that she did not believe there could be one AI teaching tool suitable for all university teachers, because teaching itself "cannot be standardised" (Participant 010). For her, institutional support should offer resources and possibilities, but should not impose uniform solutions on fundamentally diverse teaching practices.

This concern was echoed in participants' repeated calls for discipline-specific resources and differentiated support. Teachers in engineering, design, ideological education, and psychology all described different expectations from AI, shaped by the knowledge requirements, risks, and educational purposes of their own fields.

4.5.4 Sustainable implementation: incentives, costs, and institutional conditions

Finally, several participants highlighted that sustainable AI implementation depended not only on attitudes or training, but also on cost–benefit considerations and broader institutional conditions. Some teachers said explicitly that stronger incentives—such as recognition in promotion, teaching competitions, or project applications—would increase their willingness to use AI more frequently (Participant 012). At the same time, others pointed out that meaningful AI use involved real costs, including learning time, experimentation, failed attempts, and the effort required to move beyond shallow use. One participant argued that many teachers would adopt AI more actively only when the expected gains clearly outweighed the learning costs involved (Participant 014).

This balance between incentives and effort also helps explain why generic institutional encouragement was often seen as insufficient. Teachers were more likely to invest in AI when support reduced practical barriers, when tools produced visible gains, and when institutions recognised the extra labour involved in developing AI-enhanced practice. Taken together, these findings highlight the complexity of teachers' attitudes towards AI, revealing a dynamic interplay between perceived benefits, professional values, student-related concerns, and institutional conditions.

5 Discussion

5.1 AI acceptance is pedagogically negotiated, not absolute

A central argument emerging from this study is that teachers' acceptance of AI in higher education is pedagogically negotiated rather than absolute. Participants did not simply position themselves as either "for" or "against" AI. Instead, their attitudes reflected a more complex evaluative process in which AI was assessed in relation to educational purpose, disciplinary demands, and the preservation of teacher control. This finding adds nuance to technology acceptance research by suggesting that, in educational settings, acceptance hinges not just on perceived utility, but on pedagogical appropriateness within specific contexts.

Whilst findings align with the TAM regarding the role of perceived usefulness (Scherer et al., 2019), this study suggests that perceived usefulness was evaluated in relation to specific pedagogical purposes rather than treated as an inherent feature of AI. Teachers valued AI for instrumental benefits, such as lesson preparation and resource generation (Mnguni, 2025; Ren and Wu, 2025), but assessed these benefits in terms of their alignment with teaching goals and disciplinary expectations (Ofosu-Ampong, 2024). These findings extend the application of TAM and TPB to AI integration by suggesting that teachers' acceptance is shaped not only by perceived usefulness but also by professional judgement and pedagogical beliefs.

Disciplinary context and teacher agency further shape this negotiation. Across the interviews, what counts as appropriate AI use varies: creative disciplines prioritise experimentation, whilst engineering emphasises knowledge verification. Crucially, teachers favoured a human-led approach in which AI functions as a scaffold rather than a replacement (Chan and Tsi, 2024). This emphasis on human agency reflected their desire to preserve professional judgement, pedagogical responsibility, and students' independent thinking.

Finally, the range of emotional responses, from excitement to caution, suggests that teachers' attitudes towards AI cannot be explained solely by assessments of its practical usefulness (Breckler, 1984). These responses also appeared to be associated with perceived pedagogical fit. Teachers expressed enthusiasm when AI supported their teaching without compromising their professional judgement, whereas repetitive or poorly aligned outputs were associated with frustration or declining satisfaction. Importantly, favourable perceptions were frequently accompanied by intentions to use AI selectively and under teacher control. Consequently, AI acceptance is better understood not as a binary state, but as a situated and professionally negotiated stance, where instrumental value is constantly weighed against pedagogical integrity and human judgement.

5.2 Student development, rather than teacher replacement, is the core concern

Teachers' primary concern about AI centred less on professional replacement than on its implications for student development. Across the interviews, participants rarely framed AI as a direct threat to their professional roles. This finding is consistent with previous research showing that university teachers and students generally recognise the distinctive contributions of human educators that AI cannot readily replace (Chan and Tsi, 2024). Instead, participants expressed concerns that inappropriate AI use might weaken students' independent thinking, logical reasoning, and authentic understanding. Their accounts therefore shifted attention from whether AI could replace teachers to how AI might affect the learning processes that teachers considered essential.

These concerns contribute a teacher-centred perspective to existing discussions of cognitive offloading and overreliance on AI (Zhai et al., 2024). First, several participants described instances in which students appeared to rely on AI-generated answers rather than engage in independent reasoning, sometimes producing polished outputs without demonstrating corresponding understanding. Second, participants identified a related but distinct concern: some students were perceived as lacking the skills to use AI strategically for learning, relying instead on its convenience for everyday tasks or

superficial task completion. This distinction is consistent with Hou et al. (2025), who found that undergraduates' critical thinking was positively associated with reflective, cautious, and collaborative use of generative AI, whilst greater trust in AI predicted thoughtless use. These accounts suggest that teachers' concerns involved both excessive dependence and underdeveloped educational use of AI. This focus on student development helps explain why participants favoured bounded adoption rather than unrestricted use or outright rejection. In particular, teachers emphasised the need to preserve students' opportunities for independent thinking whilst allowing AI to support subsequent learning activities. Consequently, the findings suggest that, from teachers' perspectives, a central challenge of AI integration lies in ensuring that AI supports rather than bypasses meaningful learning. In this sense, the pedagogical value of AI depends on its ability to act as a scaffold for thinking rather than a substitute for it.

5.3 Sustainable integration depends on literacy, discipline, and support ecology

Sustainable AI integration depends not simply on access to tools, but on teachers' AI-related competencies, disciplinary fit, and institutional support. This aligns with previous research highlighting the competencies and contextual conditions required for meaningful AI integration in higher education (Ren and Wu, 2025). Our findings suggest that these factors need to be considered together rather than in isolation. A critical distinction emerging from participants' accounts was that between AI use and AI literacy. Whilst many participants reported using AI for routine tasks, several questioned whether such use necessarily involved informed evaluation or critical engagement. These accounts suggest that increasing AI use does not necessarily indicate the development of competencies needed for pedagogically appropriate integration. Teachers therefore emphasised the importance of developing AI literacy beyond basic tool operation, particularly the ability to evaluate outputs, formulate effective prompts, and align AI use with educational purposes. This emphasis is consistent with research advocating professional learning that addresses the pedagogical and ethical dimensions of AI integration (Mouta et al., 2025).

Furthermore, the findings highlight that individual competencies alone are insufficient if disciplinary and institutional supports are weak. Participants from different fields, including engineering and ideological and political education, expressed distinct needs for specialised tools, reliable outputs, and context-sensitive resources. These accounts reinforce the importance of moving beyond generic training towards support that responds to specific teaching requirements. This finding is consistent with Ofosu-Ampong (2024), who identified institutional support, organisational policies, and incentives as important factors associated with university teachers' AI acceptance. Similarly, Zhao and Huang (2025) found that perceived teaching resources and teaching autonomy moderated relationships between AI literacy and psychological predictors of teaching innovation amongst Chinese university teachers. Although the present study did not test these relationships, participants' accounts provide further insight into why resources, professional development, and teaching autonomy were considered important for meaningful AI integration. Sustainable integration therefore requires differentiated support systems that recognise disciplinary diversity, provide targeted professional development, and address the time, effort, and resource costs associated with adoption. Ultimately, the findings suggest that AI integration is more likely to be sustained when institutional support enables teachers to use AI in ways consistent with their disciplinary needs and professional judgement.

6 Conclusion, implications, and limitations

This study examined teachers' attitudes towards AI integration across four higher education institutions in China. The findings suggest that teachers' attitudes were not simply supportive or resistant, but were pedagogically negotiated. Participants generally recognised AI as a useful educational tool, particularly for improving efficiency, supporting teaching preparation, and extending pedagogical possibilities. At the same time, their acceptance remained conditional, shaped by disciplinary context, task type, professional judgement, and the need to preserve human control in teaching. A central concern amongst participants was not their own replacement by AI, but its potential implications for student development, particularly the risk that inappropriate AI use might weaken independent thinking, reasoning, originality, and authentic engagement. Taken together, the findings highlight the importance of moving beyond technological access to consider teachers' AI literacy, students' critical engagement with AI, and institutional support that is responsive to disciplinary and pedagogical needs.

6.1 Implications

The findings of this study have both theoretical and practical implications. Theoretically, they suggest that teachers' attitudes towards AI in higher education are better understood as a negotiated pedagogical stance than as a straightforward expression of technology acceptance. Whilst TAM and TPB remain useful for explaining the roles of perceived usefulness, intention, and control, the present study shows that these constructs are interpreted through pedagogical purpose, disciplinary expectations, and concerns about student development. The findings thus provide a contextualised understanding of AI acceptance in which cognitive appraisals and affective responses inform teachers' conditional behavioural intentions, shaped by their pedagogical purposes and concerns about student development.

The study also contributes to current discussions of AI in higher education by shifting attention from teacher displacement to student development. Participants were far more concerned that AI might weaken students' reasoning, originality, and authentic engagement than that it might replace teachers. From teachers' perspectives, the key educational issue is not simply whether AI should be adopted, but how its use could be guided to support rather than bypass meaningful learning. In this sense, the findings reinforce the need to conceptualise AI integration as a developmental and ethical issue, as much as a technological one.

Practically, the findings indicate that universities should move beyond generic promotion of AI and adopt more differentiated support strategies. First, institutions should provide targeted, practice-oriented professional development that responds to disciplinary and role-specific teaching needs rather than relying on one-off, generalised workshops. Second, teacher development should place greater

emphasis on AI literacy and prompt literacy, since frequent use does not necessarily imply competent or reflective use. Third, institutions should invest in enabling conditions for sustainable integration, including appropriate platforms, infrastructure, and, where possible, more specialised or discipline-sensitive tools, whilst respecting teachers' pedagogical autonomy. Finally, universities should pay closer attention to how students are using AI and support teachers in designing tasks, boundaries, and guidance mechanisms that preserve independent thinking, critical judgement, and authentic learning. Together, these implications point to the importance of combining pedagogically grounded adoption, student-centred guidance, and discipline-responsive institutional support.

6.2 Limitations

Several limitations should be acknowledged. First, the study was based on a relatively small sample of 14 teachers from four higher education institutions in China. Recruitment through professional and institutional networks may have introduced selection bias by favouring teachers who were more willing to discuss AI integration. Although the sample included participants from different disciplines and teaching backgrounds, the findings are context-specific and should not be assumed to represent all Chinese higher education institutions or higher education systems elsewhere. The Chinese higher education context, including the curricular expectations associated with ideological and political education, may also have influenced how some participants evaluated the appropriateness of AI-generated content. However, these contextual influences were not independently examined in this study. Second, the data were drawn from teachers' self-reported interview accounts rather than direct observations of classroom practice. As such, the findings reflect participants' perceptions, experiences, and reported behavioural intentions rather than independently verified teaching practices. In particular, teachers' concerns about students' AI use should not be interpreted as direct evidence of changes in students' cognitive abilities or learning outcomes. Third, the study focused only on teachers' perspectives. Students' experiences and institutional leaders' views were not included.

Future research could address these limitations by including larger and more diverse samples, comparing disciplinary and institutional contexts more systematically, and integrating multiple data sources such as classroom observations, student interviews, and documentary evidence. To complement teachers' perspectives, future studies could also examine students' experiences of autonomy and competence during AI use, drawing on METUX-based measures validated in the Chinese higher education context (Zhang et al., 2026). Longitudinal research would also be valuable in examining how teachers' attitudes and practices evolve as AI tools become more deeply embedded in higher education. Such work would further clarify not only whether AI is adopted, but how its integration is negotiated, bounded, and sustained in real educational settings.

Data availability statement

The anonymised research materials supporting the findings of this study are publicly available in the Open Science Framework (OSF) repository at https://osf.io/t7qu2/overview. Further inquiries may be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ningbo University of Finance and Economics. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JX: Investigation, Writing – review & editing, Formal analysis, Supervision, Project administration, Conceptualization, Writing – original draft. WZ: Writing – original draft, Formal analysis, Investigation, Funding acquisition, Methodology, Conceptualization, Writing – review & editing. SO: Formal analysis, Methodology, Data curation, Writing – review & editing, Investigation. FZ: Software, Visualization, Writing – review & editing, Data curation. SZ: Investigation, Writing – review & editing, Data curation. QJ: Data curation, Writing – review & editing, Investigation.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that Generative AI was used in the creation of this manuscript. During the preparation and revision of this manuscript, the authors used ChatGPT (OpenAI, GPT-6, web version, October 2026) to assist with English language polishing, grammar checking, and editorial refinement of the manuscript. All AI-assisted suggestions were critically reviewed by the authors, who retain full responsibility for the accuracy, integrity, and final content of the manuscript.

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