ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Leading innovation in Mathematics instruction: Integrating AI-assisted teaching in Chinese Normal Universities

Dr. Wenwu Lian*[1], Dr. Rosalie D. Meriales[2]
[1, 2] Adamson University
*Corresponding Author email: *25454599@qq.com*

Received: 18 November 2025 **Revised**: 19 December 2025 **Accepted**: 21 December 2025

Available Online: 22 December 2025

Volume IV (2025), Issue 4, P-ISSN – 2984-7567; E-ISSN - 2945-3577

https://doi.org/10.63498/etcor522

Abstract

Aim: This study examined the effectiveness and perceived impact of AI-assisted teaching tools in mathematics instruction in Chinese normal universities, with emphasis on their role in pre-service teacher education. Anchored in the Technological Pedagogical Content Knowledge (TPACK) framework, it investigated patterns of AI use, perceived instructional effectiveness, and the relationship between AI integration and student learning outcomes.

Methodology: A descriptive–comparative mixed-methods research design was employed. Quantitative data were gathered from 374 mathematics students and 49 mathematics teachers across five Chinese normal universities using a validated questionnaire with high internal consistency (Cronbach's α = 0.95). The instrument assessed AI integration across four instructional dimensions: personalized learning pathways, automated assessment and real-time feedback, data-driven instructional support, and gamification. Qualitative data were obtained through semi-structured interviews with 25 mathematics teachers. Data analysis involved descriptive statistics, Mann–Whitney U tests, Pearson correlation analysis, and thematic analysis.

Results: Findings revealed that both students and teachers frequently used AI-assisted tools in mathematics instruction. Despite this high level of use, AI was perceived as only moderately effective and moderately impactful on student learning outcomes. No significant differences were found between student and teacher perceptions across instructional dimensions. However, strong positive correlations were identified between perceived AI effectiveness and learning outcomes. Qualitative results highlighted challenges related to limited technical training and unequal access to AI tools, alongside opportunities such as enhanced personalized engagement and reduced instructional workload.

Conclusions: AI-assisted teaching tools are most effective when used as supplementary instructional support rather than as substitutes for human educators. To optimize AI integration in mathematics instruction and pre-service teacher education, targeted professional development and equitable access to technological infrastructure are essential.

Keywords: *Artificial Intelligence (AI); Mathematics Education; Chinese Normal Universities; TPACK Framework; Teacher Perceptions; Student Learning Outcomes; AI-Assisted Instruction*

INTRODUCTION

In recent decades, Artificial Intelligence (AI) has emerged as a transformative force in education, particularly in mathematics instruction, where persistent instructional problems—such as limited differentiation, delayed and inconsistent feedback, uneven learner engagement, and difficulties in supporting conceptual understanding—have long challenged both teachers and learners (Zawacki-Richter et al., 2020; Holmes et al., 2022; Lu et al., 2023). Globally, educational institutions have increasingly leveraged AI-assisted tools to address these challenges by enabling personalized learning pathways, automating assessment processes, and generating data-driven insights that support instructional decision-making and continuous improvement (Chen et al., 2020; Kasneci et al., 2023). As a global leader in AI development and implementation, China has experienced rapid expansion of AI applications in education, with AI-driven platforms widely adopted to support adaptive learning, feedback systems, and learning analytics in higher education contexts (Zhai et al., 2023; Feng & Chen, 2024). However, the adoption of

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

AI has often been framed as a technological opportunity rather than as a response to enduring pedagogical problems in mathematics education, resulting in a limited understanding of how AI meaningfully supports teaching and learning processes in specific institutional contexts.

A particularly underexamined context is that of Chinese normal universities, which are not merely another form of higher education institution but are dedicated teacher-education institutions responsible for preparing future mathematics teachers. Unlike general universities, normal universities emphasize the simultaneous development of content mastery, pedagogical competence, and professional teaching identity. AI integration in this setting, therefore, has dual implications: it influences immediate student learning in mathematics and shapes how pre-service teachers learn to teach with technology. Despite this critical role, existing research has largely focused on primary and secondary education or on general higher education, offering limited empirical evidence on AI use within teacher education environments. Previous studies have seldom examined (a) comparative perceptions between teachers and students, (b) the combined modeling of AI effectiveness and learning impact, or (c) in-depth mixed-methods evidence that explains how and why AI works in mathematics instruction. As a result, there remains a significant research gap regarding how AI-assisted instruction is experienced, interpreted, and pedagogically mediated in normal universities, where instructional decisions carry long-term implications for future classroom practice.

This study addressed these gaps by examining the implementation of AI-assisted teaching in mathematics courses across five Chinese normal universities. Specifically, the study investigated persistent instructional problems in mathematics education through the lens of AI integration, focusing on the frequency of AI-powered tool usage and the perceived effectiveness of AI tools among teachers and students in enhancing personalized learning, automated assessment and feedback, data-driven instructional support, and gamification. It further examined whether teachers and students differed in their assessments of AI effectiveness and impact, evaluated the influence of AI-assisted tools on student learning outcomes in terms of cognitive knowledge, skill development, and motivation, and analyzed the relationship between perceived AI effectiveness and learning outcomes. In addition, the study explored contextual challenges and opportunities encountered by mathematics teachers and identified capacity-building directions necessary for strengthening AI integration in teacher education settings.

The study was theoretically anchored in the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the dynamic interaction among technological and pedagogical knowledge, and content knowledge in effective teaching practice (Mishra, 2019; Willermark, 2020). In this study, TPACK informed both the selection of instructional dimensions examined—personalized learning, automated feedback, learning analytics, and gamification—and the interpretation of AI effectiveness and impact in mathematics instruction. Within mathematics education, TPACK conceptualizes AI integration not as a purely technical enhancement but as a pedagogical practice that requires intentional alignment between AI tools, instructional strategies, and curriculum goals. This perspective was particularly relevant to Chinese normal universities, where pre-service teachers were expected to develop not only technological competence but also sound pedagogical judgment in technology-rich instructional environments (Holmes et al., 2022).

This study held practical significance for multiple stakeholders. Pre-service teachers benefited from exposure to AI-supported instructional practices that enhanced their readiness for contemporary mathematics classrooms. In-service mathematics teachers gained empirical insights into effective and responsible AI integration strategies. Teacher education institutions were provided with evidence to inform curriculum development and professional training initiatives that emphasized pedagogically grounded AI use. Policymakers and educational leaders likewise benefited from data-driven guidance for decision-making related to AI infrastructure investment and teacher capacity building. The scope of the study was limited to mathematics instruction in five Chinese normal universities over one academic term. Noted limitations included reliance on self-reported data, which may not have fully captured actual classroom practices, and the absence of long-term measures of AI's impact on student achievement (Chen & Wang, 2021; Zhai et al., 2023).

Theoretical Framework

This study was anchored in the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler (2006), which conceptualized effective teaching as the dynamic interaction among content knowledge, pedagogical knowledge, and technological knowledge. Building on Shulman's (1986) Pedagogical Content Knowledge (PCK), the framework emphasized that technology-enhanced instruction required not only subject-matter expertise and sound pedagogy but also an informed understanding of how technological tools could support and transform instructional processes and learning experiences. TPACK provided a theoretical lens for analyzing how mathematics teachers in Chinese normal universities integrated AI-assisted tools into their

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

instructional practices, framing AI integration as a pedagogical process that involved aligning technological tools with mathematical content and instructional strategies rather than as a purely technical adoption. Teachers' use of AI-driven platforms for personalized learning pathways and real-time feedback reflected the synthesis of technological, pedagogical, and content knowledge, which was essential to understanding AI's role in enhancing student engagement and learning outcomes. The framework was particularly relevant to teacher education institutions responsible for preparing pre-service teachers to effectively integrate emerging technologies into classroom practice, as it enabled the study to examine both students' perceptions of AI-assisted instruction and teachers' instructional decisions and readiness. As such, the TPACK framework provided a robust theoretical foundation for examining AI integration in mathematics education and for informing curriculum development, professional training, and innovation in teacher preparation programs.

Statement of the Problem

Despite the rapid advancement and increasing integration of Artificial Intelligence (AI) in education, particularly in mathematics instruction, empirical evidence on its effective use within teacher education institutions remains limited. While previous studies have extensively examined AI-assisted teaching in primary, secondary, and general higher education contexts, relatively little is known about how AI tools are utilized and perceived in Chinese normal universities, which are responsible for preparing future mathematics teachers. This gap is critical, as pre-service teacher education plays a decisive role in shaping instructional practices, pedagogical beliefs, and technology-integration competencies.

Moreover, existing research often focuses on isolated aspects of AI integration, such as usage frequency or learning outcomes, without examining the combined perspectives of both teachers and students or the relationship between perceived instructional effectiveness and learning impact. There is also limited evidence on whether teachers and students differ significantly in their assessments of AI-assisted instruction and how such perceptions relate to actual learning outcomes. In addition, challenges related to teacher readiness, access to AI tools, and institutional support remain underexplored in teacher-training environments.

Given the growing reliance on AI-assisted platforms in mathematics instruction and the strategic importance of normal universities in educational reform, there is a pressing need for a comprehensive investigation that examines the extent, effectiveness, and impact of AI integration in this context. Addressing this gap is essential to inform evidence-based decision-making, guide capacity-building initiatives, and ensure that AI serves as a meaningful pedagogical support rather than a superficial technological addition in mathematics teacher education.

Research Objectives

General Objective

To examine the integration of AI-assisted teaching tools in mathematics instruction in Chinese normal universities.

Specific Objectives

Specifically, the study aimed to:

1. To determine the frequency of use of AI-powered tools in mathematics instruction in Chinese normal universities.
2. To assess the effectiveness of AI-assisted teaching tools in enhancing mathematics instruction, as perceived by teachers and students, in terms of:
    - personalized learning pathways;
    - automated assessment and real-time feedback;
    - data-driven instructional support and learning analytics; and
    - gamification and motivational engagement.
3. To determine whether there is a significant difference between the assessments of teachers and students regarding the effectiveness of AI tools in mathematics instruction.
4. To examine the impact of AI-powered tools on student learning outcomes in mathematics in terms of cognitive knowledge, skills development, and motivation and engagement.
5. To determine whether there is a significant difference between the assessments of teachers and students regarding the impact of AI-powered tools on student learning outcomes.

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

6. To examine the relationship between the perceived effectiveness of AI tools in mathematics instruction and their impact on student learning outcomes.
7. To identify the challenges and opportunities encountered by mathematics teachers in using AI-assisted platforms.
8. To propose a comprehensive capacity-building and innovation program to enhance the integration of AI in mathematics education.

Research Questions

This study sought to answer the following questions:

1. What is the frequency of usage of AI-powered tools in mathematics instruction in Chinese normal universities?
2. How effective are AI-assisted teaching tools in enhancing mathematics instruction, as perceived by teachers and students, in terms of personalized learning pathways, automated assessment and real-time feedback, data-driven instructional support and learning analytics, and gamification and motivational engagement?
3. Is there a significant difference between the assessments of teachers and students regarding the effectiveness of AI tools in mathematics instruction?
4. What is the impact of AI-powered tools on student learning outcomes in mathematics in terms of cognitive knowledge, skills development, and motivation and engagement?
5. Is there a significant difference between the assessments of teachers and students regarding the impact of AI-powered tools on student learning outcomes?
6. Is there a significant relationship between the perceived effectiveness of AI tools in mathematics instruction and their impact on student learning outcomes?
7. What challenges and opportunities do mathematics teachers encounter when utilizing AI-assisted platforms to support student learning?
8. What capacity-building and innovation program can be proposed to enhance AI integration in mathematics education?

Hypotheses

1. There is no significant difference between the assessments of teachers and students regarding the effectiveness of AI tools in mathematics instruction.
2. There is no significant difference between the assessments of teachers and students regarding the impact of AI-powered tools on student learning outcomes.
3. There is no significant relationship between the perceived effectiveness of AI tools in mathematics instruction and their impact on student learning outcomes.

METHODS

Research Design

This study employed a descriptive–comparative mixed-methods research design using a convergent parallel approach, selected because it enabled the simultaneous collection and analysis of quantitative and qualitative data to provide a comprehensive understanding of AI-assisted mathematics instruction in Chinese normal universities. The design was most appropriate because the study sought not only to measure the frequency, effectiveness, and impact of AI tools quantitatively, but also to explain these findings through in-depth qualitative insights drawn from teachers' lived instructional experiences. The quantitative component addressed the extent and perceived effectiveness of AI use and its relationship with learning outcomes, while the qualitative component explored contextual factors, challenges, and pedagogical reasoning that could not be captured through survey data alone. The integration of descriptive, comparative, and qualitative elements enabled the study to triangulate results, strengthen interpretive validity, and provide a richer explanation of how and why AI tools functioned within mathematics instruction in teacher-education contexts. A convergent mixed-methods design was deemed suitable because both data strands were given equal priority, collected during the same phase of the study, analyzed independently, and integrated during interpretation to corroborate and expand the findings.

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Population and Sampling

The study was conducted in five Chinese normal universities, involving 374 mathematics students and 49 mathematics teachers**.** It is important to note that the quantitative respondents and qualitative participants were not identical groups. Quantitative data were collected from both students and teachers, whereas qualitative data were obtained exclusively from a subset of mathematics teachers. A purposive sampling technique was applied. Students were selected for their enrollment in mathematics courses that incorporated AI-assisted instructional tools**,** ensuring that they had direct experience with AI-supported learning. Teachers were selected based on their active role in implementing AI-assisted instruction**,** enabling them to provide informed reflections on pedagogical practices and challenges. The sample size was considered adequate for the study's objectives, as it allowed for meaningful statistical analysis of group comparisons and relationships in the quantitative phase, and the qualitative sample size was sufficient to achieve thematic saturation, as recurring patterns emerged across interviews.

Research Instruments

Quantitative data were gathered using a researcher-developed questionnaire, designed to measure AI-assisted instruction across four dimensions: personalized learning pathways, automated assessment with real-time feedback, data-driven instructional support and learning analytics, and gamification and motivational engagement. The instrument was grounded in the TPACK framework, which informed the selection and operationalization of these dimensions. The questionnaire underwent expert validation by three validators with doctoral qualifications and professional experience in mathematics education, educational technology, and AI-supported instruction, respectively. Validators reviewed the instrument for content relevance, construct alignment, clarity, and appropriateness to the teacher-education context. Revisions were made based on their feedback prior to data collection. Reliability testing yielded a Cronbach's alpha coefficient of 0.95**,** indicating excellent internal consistency. A separate semi-structured interview guide was developed for the qualitative phase**,** distinct from the quantitative questionnaire. The guide focused on teachers' experiences with AI-assisted instruction, perceived challenges, pedagogical adaptations, and opportunities for instructional improvement. Interview questions were aligned with the quantitative dimensions to support later integration of findings while allowing participants to elaborate on context-specific experiences.

Data Collection Procedures

Quantitative data were collected during one academic term through the administration of structured questionnaires to mathematics students and teachers. Surveys were distributed in print or electronically, depending on institutional access and participant preference. All respondents completed the questionnaire independently, and responses were collected and encoded for analysis upon completion. Qualitative data were collected concurrently with the quantitative phase through semi-structured interviews with selected mathematics teachers. Interviews were conducted either face-to-face or online, depending on availability and institutional protocols, and followed a standardized interview guide. Each interview focused on participants' direct instructional experiences with AI tools and lasted approximately 30–45 minutes.

Data Analysis and Integration

Quantitative and qualitative data were analyzed separately before integration**.** Quantitative data were analyzed using jamovi version 2.3.19. The Shapiro–Wilk test was used to assess normality, and as assumptions of normality were not met, non-parametric statistical techniques were employed, including descriptive statistics, Mann–Whitney U tests for group comparisons, and correlation analyses to examine relationships among variables. Qualitative data were analyzed using thematic analysis, following systematic coding procedures that involved familiarization with the data, initial coding, theme development, and refinement. The analysis was study-specific, focusing on instructional challenges, pedagogical alignment, equity concerns, and motivational affordances of AI-assisted instruction. Integration of the quantitative and qualitative findings occurred during the interpretation phase. Quantitative results provided patterns and relationships, while qualitative findings explained, contextualized, and elaborated on them. This integration strengthened the study's explanatory power by linking statistical trends with teachers' experiential insights.

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Ethical Considerations

Ethical considerations were addressed separately from data collection procedures. The study adhered to established ethical research standards, including informed consent, voluntary participation, anonymity, confidentiality, and responsible data handling. No conflicts of interest were declared.

RESULTS AND DISCUSSION

Frequency of Usage of AI-powered Tools in Mathematics Instruction in Chinese Normal Universities

Table 1

Assessment of Frequency of Usage of AI-Powered Tools in Mathematics Instruction in Chinese Normal Universities

	Indicators	Group	Mean	SD	Verbal Interpretation	Rank
1.	AI-driven adaptive learning platforms (e.g., Zhihuishu, Yuketang, Icourse(MOOC))	Students	4.56	0.62	Very Often	1
		Teachers	4.49	0.71	Often	1
2.	Automated assessment and grading tools	Students	4.18	0.84	Often	4
		Teachers	4.08	0.89	Often	4
3.	AI-based tutoring/chatbot systems for math problem solving	Students	4.30	0.75	Often	2
		Teachers	4.33	0.75	Often	2
4.	AI tools for generating practice exercises and exams	Students	4.25	0.78	Often	3
		Teachers	4.16	0.85	Often	3
5.	AI-powered visualization and simulation software	Students	3.88	0.76	Often	5
		Teachers	3.76	0.80	Often	5
6.	AI-assisted plagiarism detection or academic integrity tools	Students	2.87	1.28	Sometimes	6
		Teachers	2.51	1.34	Sometimes	6
	COMPOSITE MEAN					
		Students	**4.00**	**0.52**	**Often**	
		Teachers	**3.89**	**0.59**	**Often**	

Legend: 1.00-1.50: Never; 1.51-2.50: Rarely; 2.51-3.50; Sometimes; 3.51-4.50: Often; 4.51-5.00: Very Often

Table 1 presents the assessment of the frequency of use of AI-powered tools in mathematics instruction at Chinese normal institutions. Based on the tabulated data, the students had an overall mean score of 4.00 (SD = 0.52), while the teachers had an overall mean score of 3.89 (SD = 0.59), indicating that both groups frequently employed AI-powered tools to teach Mathematics. In particular, both groups frequently use AI-driven adaptive learning platforms (M = 4.56; 4.49), AI-based tutoring/chatbot systems for math problem solving (M = 4.30; 4.33), and AI tools for creating practice exercises and tests. On the other hand, both groups occasionally employ AI-assisted plagiarism detection or academic integrity programs (M = 2.86; 2.51).

These findings indicated that AI adoption in mathematics instruction primarily focused on instructional support and learning facilitation rather than monitoring or surveillance. This pattern suggested that teachers and students prioritized AI applications that directly enhance understanding, practice, and feedback in mathematics learning. Similar trends were reported in recent studies, which found that adaptive and conversational AI systems were increasingly integrated into mathematics instruction due to their capacity to personalize learning and provide immediate formative feedback (Lu et al., 2023; Zhai et al., 2023; Holmes et al., 2022).

From the perspective of the present study, the selective use of AI tools highlighted how AI integration served as a pedagogical response to instructional challenges rather than a comprehensive technological solution. This pattern aligned with the TPACK framework, in which technology was integrated to support pedagogical intent and content goals, rather than adopted indiscriminately (Mishra, 2019; Willermark, 2020).

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Table 2

Frequency and Percentage of Other AI-Powered Tools

Other AI-Powered Tools	Frequency	Percentage
AI Agent	30	7%
ChatGPT	19	4%
Deepseek	73	17%
Doubao	151	36%
Null	124	29%
Others	26	6%

Table 2 shows the number and proportion of respondents who used other AI-powered tools. The data analysis found that 7% employed an AI agent, 4% used ChatGPT, 17% used Deepseek, 36% used Doubao, 29% used Null, and 6% used other AI-powered tools. This suggests that most of them used Doubao as an artificial intelligence tool in mathematics.

Doubao's dominance suggests that localized or region-specific AI applications are becoming increasingly popular in Chinese higher education. This is consistent with recent research showing that domestic AI platforms that support multilingual, data-secure, and pedagogically adaptive environments are increasingly adopted by universities (Zhai et al., 2023; Feng & Chen, 2024).

Language interface barriers, data privacy laws, and institutional restrictions may explain the limited use of ChatGPT and generic AI agents in the classroom (Kasneci et al., 2023; UNESCO, 2021). In a similar vein, rather than being widely adopted, educators' experimentation with Deepseek and Null suggests they are seeking alignment between the tools' capabilities and curriculum objectives (Lu et al., 2023). According to TPACK, these adoption patterns show how teachers choose platforms like Doubao that better fit their instructional context and carefully combine their technological expertise with current pedagogical and content practices. This selective adaptation indicates a context-sensitive evolution of TPACK in Chinese mathematics education by illuminating the pragmatic negotiation teachers engage in when balancing AI affordances with curricular and linguistic realities (Mishra, 2019; Willermark, 2020).

Table 3

Assessment of the Effectiveness of AI Tools in Enhancing Mathematics Instruction

Variables	Group	Mean	SD	Verbal Interpretation
Personalized Learning Pathway	Students	3.20	0.49	Moderately
Automated Assessment and Real-Time	Teachers	3.20	0.50	Effective
Feedback	Students	3.19	0.49	Moderately
Data-Driven Instructional Support and	Teachers	3.14	0.53	Effective
Learning Analytics	Students	3.18	0.49	Moderately
Gamification and Motivational	Teachers	3.14	0.57	Effective
Engagement				
Effectiveness of AI Tools	Students	3.22	0.50	Moderately
	Teachers	3.14	0.58	Effective
	Students	**3.20**	**0.46**	**Moderately**
	Teachers	**3.16**	**0.51**	**Effective**

Legend: 1.00-1.50: Strongly Disagree (Not Effective at All); 1.51-2.50: Disagree (Slightly Effective); 2.51-3.50; Agree (Moderately Effective); 3.51-4.00: Strongly Agree (Very Effective)

Table 3 summarizes the perceived effectiveness of AI-assisted teaching tools in enhancing mathematics instruction across four dimensions: personalized learning pathways, automated assessment and real-time feedback, data-driven instructional support and learning analytics, and gamification and motivational engagement. Overall, both students (M = 3.20, SD = 0.46) and teachers (M = 3.16, SD = 0.51) rated AI tools as moderately effective, indicating general agreement that AI contributed positively to mathematics instruction but had not yet reached a level perceived as highly transformative. The close proximity of the mean ratings across groups also suggests convergence in how AI is experienced in the same institutional environment, where both learners and instructors interact with similar platforms, feedback systems, and AI-supported learning routines. This pattern supports evidence

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

from recent higher education studies showing that AI tools are commonly perceived as helpful instructional enhancers—particularly for efficiency and personalization—yet are not consistently viewed as replacements for teacher-mediated instruction due to concerns about contextual accuracy, pedagogical fit, and ethical issues (Zawacki-Richter et al., 2020; Zhai et al., 2023; Kasneci et al., 2023).

Among the four dimensions, gamification and motivational engagement obtained the highest mean for students (M = 3.22, SD = 0.50), suggesting that interactive and game-like AI features were among the most valued affordances from the learner perspective. This aligns with recent findings that AI-supported gamification can improve learner engagement and reduce affective barriers such as mathematics anxiety by making learning more interactive and reinforcing persistence through immediate feedback and progress cues (Holmes et al., 2022; Lu et al., 2023). In contrast, teachers consistently provided slightly lower ratings in gamification (M = 3.14, SD = 0.58) and in analytics-related use (M = 3.14, SD = 0.57), reflecting cautious optimism: teachers acknowledged motivational and analytical benefits but remained reserved about whether these features consistently supported deeper conceptual understanding and long-term mastery. Similar teacher reservations have been documented in recent scholarship, emphasizing that analytics and gamification require pedagogical mediation to avoid shallow engagement, overreliance on automation, or misinterpretation of learning data (Kasneci et al., 2023; Feng & Chen, 2024).

With respect to personalized learning pathways, both students and teachers registered identical composite means (M = 3.20), indicating shared agreement that AI supported differentiated pacing and practice in mathematics learning. This consistency aligns with recent evidence that AI-driven personalization can enhance learning efficiency by tailoring tasks to learners' readiness levels and providing iterative practice opportunities that reinforce procedural fluency (Lu et al., 2023; Zhai et al., 2023). Similarly, automated assessment and real-time feedback received moderately effective ratings (students: M = 3.19; teachers: M = 3.14), suggesting that instant feedback and error correction were beneficial but not universally perceived as fully sufficient for conceptual learning. Current research similarly reports that while automated feedback improves self-regulated learning and reduces turnaround time in problem-solving tasks, it must be complemented by teacher-guided explanation and contextual scaffolding to ensure meaningful mathematical reasoning (Holmes et al., 2022; Kasneci et al., 2023).

Viewed through the TPACK framework, the findings indicate a developing stage of technology integration rather than full pedagogical transformation. The moderate ratings imply that AI tools were being used effectively at the intersection of Technological Knowledge (TK) and Pedagogical Knowledge (PK)—where tools support pacing, feedback, monitoring, and engagement—yet teachers' slightly lower means suggest that integration had not consistently advanced to a more mature level where technology use is seamlessly aligned with disciplinary content goals and complex instructional decision-making. In TPACK terms, this pattern reflects partial enactment of Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK), while full TPACK alignment (technology + pedagogy + mathematical content) remained in progress. This interpretation is consistent with recent discussions that effective AI integration depends less on access to tools and more on educators' capacity to align AI affordances with curriculum standards, pedagogical intent, and learners' cognitive needs (Willermark, 2020; Holmes et al., 2022). Therefore, the results imply that strengthening teachers' data literacy, AI pedagogical design skills, and ethical decision-making through targeted professional development may increase effectiveness ratings and move AI integration toward full TPACK-informed practice, where AI serves as a strategic instructional partner that supports both conceptual understanding and sustained learner motivation.

Challenges and Opportunities Mathematics Teachers Encountered When Utilizing AI-Assisted Platforms to Support Student Learning

Semi-structured interviews with 25 mathematics teachers from five Chinese normal universities were conducted to complement the quantitative findings and to examine challenges and opportunities in AI-assisted mathematics instruction. Thematic analysis generated five interrelated themes reflecting teachers' lived experiences and pedagogical reasoning.

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Theme 1: Technology Integration Learning Curve

Teachers described initial enthusiasm accompanied by uncertainty during early AI adoption. One teacher shared, "I was initially thrilled but confused. I knew AI could be useful, but I was unsure where to begin." Another noted, "The majority of us experimented after class… there is no official training," while a third reflected, "AI forces me to rediscover how to learn." These responses indicate that teachers assumed dual roles as instructors and learners, with AI integration progressing through self-directed experimentation. The absence of structured training limited confident implementation, suggesting that institutional support is essential for integrating technological knowledge with pedagogical practice in mathematics instruction.

Theme 2: Pedagogical Relevance and Alignment

Teachers emphasized the need to adapt AI-generated content to curriculum standards and learner contexts. As one participant stated, "The local curriculum does not align with certain AI-generated problems." Another observed, "AI is intelligent but insensitive… it cannot recognize emotional misunderstanding," while a third explained, "Pupils need more than correct answers; they need reasoning." These insights show that AI tools require teacher mediation to ensure conceptual depth and cultural relevance, reinforcing the idea that effective AI use depends on aligning technology with pedagogical intent and mathematical content rather than relying solely on automation.

Theme 3: Harmonizing Human Relationships and Technological Efficiency

Teachers consistently underscored the irreplaceable human dimension of teaching. One teacher stated, "Steps can be taught by AI, but empathy cannot," while another remarked, "I am the one who can determine when a student is losing confidence." A third shared, "I use AI to speed up grading so I can spend more time talking to my students." These responses reflect the perception of AI as a tool that enhances efficiency while preserving teacher agency, allowing educators to focus on mentorship, emotional support, and instructional decision-making that technology cannot replicate.

Theme 4: Inequalities in Access and Readiness

Concerns about inequity emerged strongly across interviews. Teachers reported that "some students fall behind even before we start because they cannot access AI platforms at home," and noted that "device quality and internet connection matter as much as talent." Others observed that AI tools intimidated struggling students while benefiting more confident learners. These accounts highlight how unequal access and readiness shaped the effectiveness of AI-assisted instruction, indicating that technological integration must be supported by inclusive infrastructure and digital support to prevent the widening of learning gaps.

Theme 5: Personalization as Motivation and Empowerment

Teachers observed that AI-driven personalization positively influenced student engagement and confidence. One teacher shared, "Students who used to dread math now look forward to solving problems," while another explained, "Immediate feedback inspires them because they see progress right away." A third noted, "Timid students can rehearse privately before presenting." These experiences suggest that adaptive feedback and private practice supported motivation and self-regulated learning, particularly when personalization was guided by clear instructional goals and teacher oversight to ensure meaningful mathematical understanding.

Across all themes, teachers consistently characterized AI as a supportive instructional partner rather than a replacement for human instruction. Their experiences reflect a gradual shift from uncertainty toward a more reflective, context-sensitive integration, demonstrating that effective AI use in mathematics education is fundamentally pedagogical, ethical, and human-centered.

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Summary of Findings

Both teachers and students reported that AI tools had become a regular component of mathematics instruction in Chinese normal universities. AI tools were most frequently used for adaptive learning platforms, tutoring or chatbot systems, practice generation, and automated assessment, whereas tools for plagiarism detection and academic integrity were used only occasionally. Overall, respondents rated AI as frequently used but only moderately effective in supporting personalized learning, real-time feedback, learning analytics, and gamified engagement. Similarly, AI was perceived to have a moderate impact on learning outcomes, including cognitive understanding, skill development, and motivation. Teachers and students demonstrated highly similar evaluations, indicating a shared and pragmatic understanding of AI's instructional affordances and limitations. Importantly, the findings showed a strong positive relationship between perceived AI effectiveness and its impact on learning outcomes. Qualitative data added contextual depth, revealing that teachers valued AI for reducing workload and supporting practice, while also highlighting persistent challenges related to limited training and unequal student access.

Conclusions

The findings indicated that AI-assisted tools contributed meaningfully to mathematics instruction, but their effectiveness was neither automatic nor inherent. Rather than functioning as a transformative solution in isolation, AI operated most effectively as a supportive instructional partner, facilitating repetitive practice, timely feedback, and individualized learning pathways, while teachers remained central to conceptual explanation, pedagogical judgment, motivation, and ethical guidance. The absence of statistically significant differences between teacher and student assessments suggested a shared adaptation to AI-supported learning environments within the same institutional context. However, the consistently moderate ratings across all dimensions indicated that instructional impact depended less on the technology itself and more on the quality of pedagogical integration. When AI use was purposefully guided, aligned with curricular goals, and mediated through sound teaching practices, it strengthened learning outcomes; when such alignment was weak, its instructional potential remained constrained. These findings underscore that AI-enhanced mathematics instruction only works when embedded within human-centered, pedagogically coherent teaching frameworks.

Recommendations

To strengthen AI integration in mathematics education, higher education institutions may benefit from moving beyond ad hoc or trial-and-error approaches by establishing clear institutional policies, ethical guidelines, and pedagogically grounded standards for AI-assisted instruction. Targeted professional development initiatives could support teachers in interpreting AI-generated feedback, using learning analytics meaningfully, and designing instruction in which AI complements rather than supplants conceptual understanding and higher-order thinking. In addition, addressing disparities in access remains critical, as equitable technological infrastructure, device availability, and digital support services appear necessary for students to benefit fully from AI-supported learning. Finally, ongoing monitoring and feedback mechanisms that incorporate both teacher and student perspectives may enable AI tools to be refined, contextualized, and aligned more closely with instructional goals over time. Through sustained institutional support, reflective practice, and informed leadership, AI may progressively evolve from a supplemental resource into a strategically integrated component of effective mathematics education.

REFERENCES

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access, 8*, 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

Chen, Y., & Wang, Q. (2021). Artificial intelligence in higher education: Opportunities and challenges. *Educational*

ETCOR
INTERNATIONAL MULTIDISCIPLINARY RESEARCH CONFERENCE
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749
SEC Registration No.: 2024020137294-00
Sta. Ana, Pampanga, Philippines
Website: https://etcor.org
iJOINED ETCOR
P - ISSN 2984-7567
E - ISSN 2945-3577
The Exigency
P - ISSN 2984-7842
E - ISSN 1908-3181

Technology Research and Development, 69(6), 2891–2915. https://doi.org/10.1007/s11423-021-10037-6

Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2023). ChatGPT and assessment: Exploring the ethical implications of generative AI in higher education. *Assessment & Evaluation in Higher Education, 49*(1), 1–15. https://doi.org/10.1080/02602938.2023.2237424

Feng, S., & Chen, G. (2024). Teachers' perceptions of artificial intelligence–assisted instruction in Chinese higher education. *Education and Information Technologies, 29*(2), 1831–1850. https://doi.org/10.1007/s10639-023-11985-2

Holmes, W., Bialik, M., & Fadel, C. (2022). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Krusche, S., & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences, 103*, 102274. https://doi.org/10.1016/j.lindif.2023.102274

Lu, Y., Wang, T., & Huang, R. (2023). Artificial intelligence–supported mathematics learning: Effects on student engagement and performance in higher education. *Computers & Education, 195*, 104694. https://doi.org/10.1016/j.compedu.2023.104694

Mishra, P. (2019). Considering contextual knowledge: The TPACK diagram gets an upgrade. *Journal of Digital Learning in Teacher Education, 35*(2), 76–78. https://doi.org/10.1080/21532974.2019.1588611

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

UNESCO. (2021). *AI and education: Guidance for policy-makers*. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000376709

Willermark, S. (2020). Technological pedagogical and content knowledge: A review of empirical studies published from 2011 to 2016. *Journal of Educational Computing Research, 58*(2), 315–343. https://doi.org/10.1177/0735633119848984

Zhai, X., He, P., & Li, Y. (2023). Artificial intelligence in education: A meta-analysis of learning outcomes and pedagogical implications. *Educational Research Review, 39*, 100489. https://doi.org/10.1016/j.edurev.2023.100489

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2020). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education, 17*(1), 1–27. https://doi.org/10.1186/s41239-020-00217-0