RESEARCH ARTICLE

Generative Artificial Intelligence in University Mathematics Instruction: Faculty Use and Future Prospects

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Abstract

Generative artificial intelligence (GenAI) is increasingly influencing university teaching, yet research on how mathematics faculty perceive and adopt these tools remains limited. This study investigates four key areas related to GenAI use in higher education: faculty AI literacy, intelligent technological pedagogical content knowledge (TPACK), perceived trust in GenAI outputs, and overall acceptance of GenAI in mathematics instruction. An online survey was administered to mathematics faculty in Saudi universities. The results show that ChatGPT is the most widely used GenAI tool among participants, indicating its central role in current instructional practices. Findings also reveal generally positive attitudes toward GenAI, alongside cautious levels of trust, particularly regarding the accuracy of AI-generated mathematical solutions. Acceptance of GenAI was found to be closely associated with higher levels of AI literacy, stronger intelligent TPACK, and greater perceived trust. Overall, the study provides insight into faculty readiness for GenAI integration, highlighting both opportunities and ongoing challenges. This exploratory research contributes to the growing literature on GenAI adoption in higher education and offers guidance for professional development initiatives aimed at supporting ethical, effective, and pedagogically informed use of GenAI in university mathematics instruction.

Keywords: university mathematics, GenAI, ChatGPT, TPACK, trust, acceptance.

1. Introduction

1.1. Background

The term artificial intelligence (AI) is commonly used to describe machines capable of mimicking aspects of human intelligence, including cognitive functions such as problem-solving, reasoning, and learning (IBM Data & AI Team, 2023). Recent advances in AI have been driven in particular by large language models (LLMs), which are designed to generate human-like text by learning patterns from vast amounts of data. One of the common examples of such models is the Generative Pre-trained Transformer (GPT) developed by OpenAI. ChatGPT is a widely used, user-friendly interface built on GPT technology, making GenAI tools easily accessible to the public. Alongside ChatGPT, a growing range of GenAI software interfaces has emerged, contributing to the increasing presence of GenAI in educational contexts, including university mathematics instruction.

In mathematics education, GenAI can support problem-solving, lesson preparation, and enhance student engagement through interactive and adaptive learning resources. Despite these potential benefits, adoption is not automatic. Faculty readiness, confidence, and trust in GenAI play a central role in determining how widely these tools are used.

Recent research has also highlighted growing interest in understanding how faculty and students perceive the role of GenAI in higher education. For example, Kim et al. (2025) reported generally positive attitudes toward GenAI among university faculty and students, while also identifying concerns related to reliability, ethics, and effective integration into teaching practice. These findings suggest that although GenAI is increasingly accepted in higher education, questions remain regarding its pedagogical use and responsible implementation.

Recent studies have also reported mixed findings regarding the educational impact of Generative AI in higher education. While AI tools are often perceived as useful for supporting learning, debugging, generating explanations, and improving efficiency, concerns remain regarding over-reliance, inaccuracies, and the potential impact on students' independent problem-solving and critical thinking skills (Lepp and Kaimre, 2025). These findings suggest that although GenAI offers important educational opportunities, its effective pedagogical integration remains an ongoing challenge.

This study is grounded in the Technology Acceptance Model (TAM) developed by Davis (1985), a well-established framework for understanding how users accept or reject new technologies. According to Davis (1989), perceived usefulness and perceived ease of use are the two core factors that strongly influence individuals' decisions to adopt a technology. However, focusing solely on these factors may not fully explain educators' acceptance of GenAI, given the advanced and transformative nature of these tools.

The concept of intelligent technological pedagogical content knowledge (TPACK) suggests that educators require more than general technical skills; they also need AI-related pedagogical knowledge to use GenAI effectively (Celik, 2023). AI literacy is similarly important, as teachers need to understand how AI works, its limitations, and its ethical implications (Laupichler et al., 2022). Beyond knowledge, trust in GenAI tools plays a critical role, as educators are more likely to adopt these technologies when they perceive them as reliable and safe (Nazaretsky et al., 2022). This study investigates mathematics faculty experiences with GenAI in Saudi universities by examining AI literacy, pedagogical integration (intelligent TPACK), perceived trust, and acceptance.

1.2. Research questions

The following research questions were considered.

RQ1 (AI Literacy): How familiar and confident are university mathematics faculty in identifying, using, evaluating, and guiding the use of GenAI?

RQ2 (Intelligent TPACK): How do university mathematics faculty integrate GenAI into their teaching within the technological pedagogical content knowledge (TPACK) framework?

RQ3 (Perceived Trust): To what extent do university mathematics faculty trust GenAI outputs in mathematics instruction?

RQ4 (Acceptance): What factors are associated with the acceptance of GenAI among university mathematics faculty?

2. Method

2.1. Design and administration of survey

An online survey was designed using a mixture of open-response, multiple-choice, and Likert-scale questions. Survey items were adapted from and inspired by the study of Al-Abdullatif (2024), particularly in relation to faculty perceptions, AI literacy, and technology acceptance. Participants were recruited using purposive sampling through university email lists and direct communication with heads of mathematics departments at Saudi universities, who were asked to circulate the survey among faculty members teaching undergraduate mathematics courses. The study targeted instructors teaching foundational mathematics subjects across a range of disciplines, including

mathematics majors and service courses for engineering, computing, and science programmes. Faculty teaching mathematics-related courses outside mathematics departments were also eligible to participate where they were involved in teaching these foundational subjects. Responses from participants who did not teach foundational mathematics courses were excluded from the final analysis.

Particular emphasis was placed on foundational subjects such as calculus, linear algebra, discrete mathematics, and principles of statistics, which are identified in the Education and Training Evaluation Commission (ETEC) framework as core knowledge units in undergraduate mathematics programmes (ETEC, 2024). By focusing on these courses, responses could be compared more directly, which would be difficult when including a broader range of subjects. This restriction does skew the results toward courses which typically have larger classes and are taught in the earlier years.

In Saudi higher education, foundational mathematics courses are typically delivered through a combination of lectures, tutorials, and problem-solving sessions, particularly in programmes serving engineering, computing, and science disciplines. These courses often involve medium- to large-sized classes and place strong emphasis on procedural fluency, conceptual understanding, and assessment through coursework, quizzes, and examinations.

For each construct (AI literacy, intelligent TPACK, perceived trust, and acceptance), composite scale scores for each construct were calculated by averaging responses across the corresponding Likert-scale items. Negatively worded items within the perceived trust construct were reverse coded prior to analysis to ensure that higher scores consistently reflected higher levels of trust. Spearman's rank correlation analysis was then used to examine relationships among the four constructs, as the data were ordinal in nature and the sample size was relatively small.

The study was conducted in accordance with the ethical guidelines of the Saudi Electronic University (CSTS-202510-001, issued on 17 November 2025). Informed consent was obtained from all participants prior to data collection. The survey questions are provided in the Appendix. The datasets generated and/or analysed during the current study are not publicly available due to privacy considerations.

2.2. Analysis of responses

The analysis primarily employed quantitative methods, supplemented by qualitative interpretation of the open-ended responses. The survey included demographic questions followed by Likert-scale items measuring four constructs: AI literacy, intelligent TPACK, perceived trust, and acceptance of GenAI tools, with responses recorded on a five-point scale from Strongly Disagree to Strongly Agree (see Appendix).

Internal consistency of the survey scales was assessed using Cronbach's alpha. The Acceptance scale showed excellent reliability ($\alpha = .91$), while the AI literacy ($\alpha = .87$) and intelligent TPACK ($\alpha = .86$) scales demonstrated good reliability. The perceived trust scale yielded lower reliability ($\alpha = .63$), which was acceptable given the exploratory nature of the study and the small number of items. Composite mean scores were computed for each construct and used in the quantitative analyses.

Descriptive statistics were used to address RQ1–RQ3, and Spearman's correlation analysis examined associations between acceptance and the key factors for RQ4. The survey also included two open-ended questions inviting participants to share recommendations and identify challenges or concerns; these responses were analysed using content analysis to identify emergent themes.

This process enabled the qualitative data to be reduced and summarised into categories reflecting participants' perspectives (Ingleby, 2012).

3. Results

Between 30 November and 30 December 2025, approximately 120 faculty members were invited to participate, of whom 55 completed the survey, representing a response rate of approximately 46%. The study was exploratory in nature and involved participants representing a range of undergraduate mathematics teaching contexts. Question 2 was used to identify the courses taught by participants during the 2024–2025 academic year. The distribution of courses indicates that most responses came from instructors teaching core mathematics subjects. When combined, participants who taught Calculus only (25%), Linear Algebra only (27%), or Discrete Mathematics only (22%) accounted for 74% of the sample, reflecting the study's emphasis on foundational mathematics instruction. In comparison, 26% of participants reported teaching statistics-related courses, such as Principles of Statistics, Quantitative Methods, or Operational Research. Overall, these findings confirm that the sample predominantly represents faculty teaching foundational mathematics courses, aligning with the intended focus of the study.

Question 3 asked participants which GenAI tools they had used in their teaching or academic work. ChatGPT was the most frequently reported tool, used by over 80% of participants, indicating its central role in current instructional practice. Other commonly reported tools included Mathway and Wolfram Alpha, although these were used less frequently. Participants also identified additional platforms through the open-response option, including Gemini, Copilot, Manus, Symbolab, and institution-specific AI systems.

As multiple responses were permitted, the findings reflect frequency of use rather than exclusive use. Approximately one-fifth of participants who reported using ChatGPT also indicated use of at least one additional tool, most commonly Wolfram Alpha or Mathway. This pattern suggests that ChatGPT may complement, rather than replace, more specialised mathematical systems, with different tools supporting different aspects of mathematical problem-solving and instructional preparation.

3.1 AI Literacy (RQ1;Survey Q4)

AI literacy was assessed using four items capturing faculty self-reported confidence in identifying, using, evaluating, and guiding the use of GenAI tools in mathematics teaching (see Figure 1).

Overall, responses indicate moderate levels of perceived AI literacy among participants. Many faculty members reported confidence in recognising and using GenAI tools, suggesting a degree of familiarity with these technologies in their teaching practice. However, responses related to evaluating AI-generated outputs and guiding students in their use showed similar distributions, with substantial proportions of participants selecting neutral responses.

These findings suggest that participants generally perceived themselves as reasonably familiar with GenAI tools, while also expressing some uncertainty regarding more advanced evaluative and pedagogical aspects of AI use. Given that the items measured self-reported perceptions rather than objective AI literacy, the findings should be interpreted cautiously.

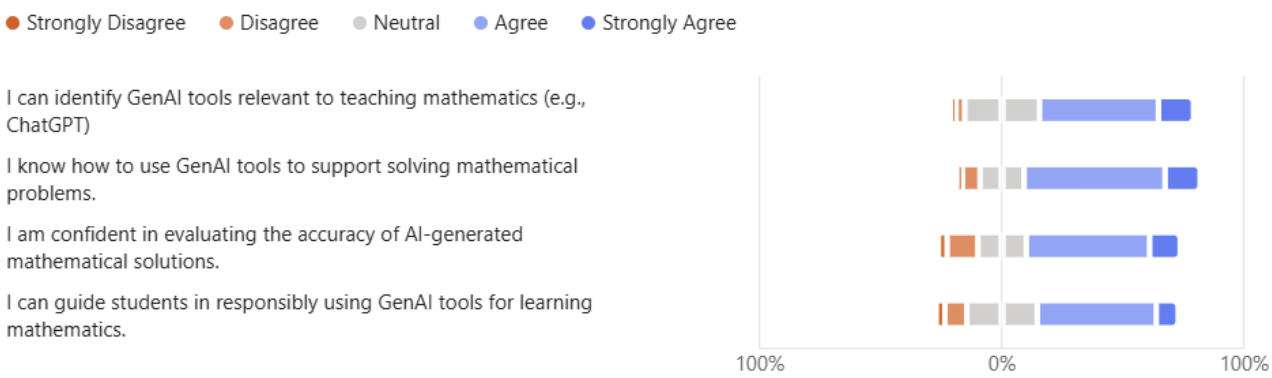

Figure 1. Responses to AI literacy items (Q4), showing faculty familiarity and confidence in identifying, using, evaluating, and guiding the use of GenAI in mathematics teaching.

3.2 Intelligent TPACK (RQ2; Survey Q5)

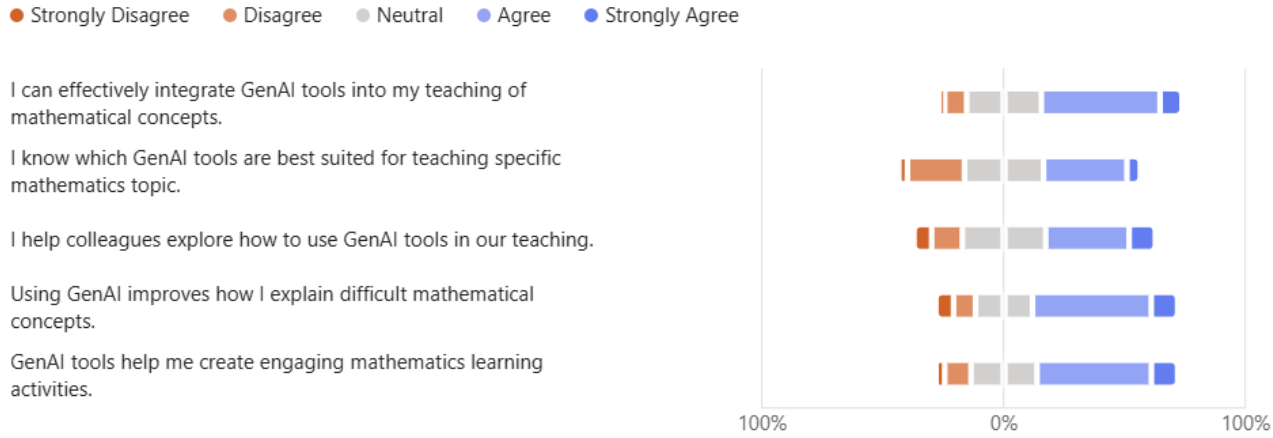

Figure 2. Responses to intelligent TPACK items (Q5), illustrating faculty confidence in integrating and applying GenAI within the mathematics teaching context.

Intelligent TPACK was assessed through items examining faculty confidence in integrating GenAI into mathematics teaching, including selecting appropriate tools, explaining concepts, and designing learning activities (see Figure 2).

Overall, responses suggest moderate levels of pedagogical confidence in using GenAI. Many participants indicated that they are able to incorporate GenAI tools into their teaching and use them to support explanation and learning activities. However, this confidence was not uniformly strong across all areas.

A consistent feature across the items was the relatively high proportion of neutral responses, indicating uncertainty in applying GenAI within specific pedagogical contexts. This was particularly evident in relation to selecting appropriate tools for different mathematical topics and designing effective learning activities. These patterns suggest that while faculty recognise the potential of GenAI, they may lack clear strategies for aligning its use with subject-specific teaching goals.

Taken together, the findings indicate that GenAI is being adopted at a practical level, but its integration within the technological pedagogical content knowledge framework remains developing

rather than fully established. This highlights the need for targeted support that focuses not only on tool use, but also on pedagogical decision-making and subject-specific application.

3.3 Perceived Trust (RQ3; Survey Q6)

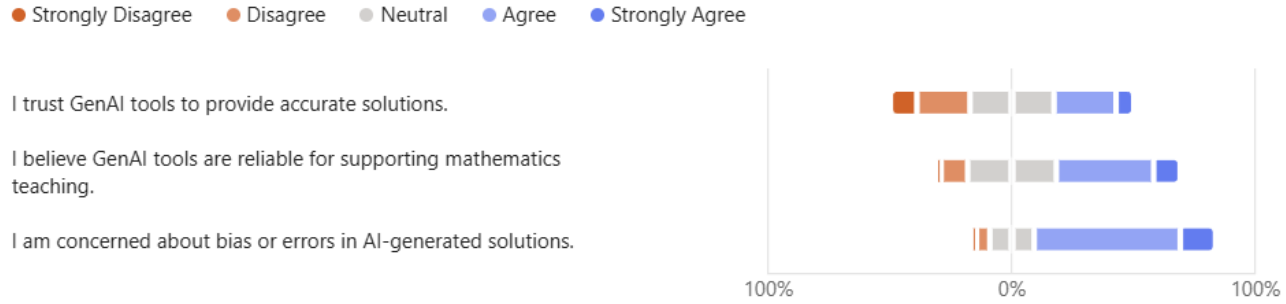

Figure 3. Responses to perceived trust items (Q6), illustrating faculty trust in GenAI outputs and concerns about accuracy and bias.

Perceived trust was assessed through items examining faculty confidence in the accuracy and reliability of GenAI outputs, as well as their concerns about potential errors or bias (see Figure 3).

Overall, responses indicate cautious and conditional trust in GenAI tools. While some participants expressed confidence in the reliability of AI-generated outputs, this was accompanied by a substantial level of uncertainty, reflected in a high number of neutral responses. This suggests that trust in GenAI is not firmly established, but remains tentative. This cautious level of trust may be explained by widespread concerns regarding errors and bias in AI-generated outputs.

Faculty appear willing to use GenAI tools, but emphasise the importance of verifying outputs and applying critical judgement. Taken together, these findings suggest that faculty trust in GenAI is cautious rather than unconditional. Instructors appear willing to use these tools in their teaching, but remain aware of their limitations, particularly the risk of errors or bias. As a result, they recognise the need for careful verification of AI-generated outputs.

3.4 Acceptance (RQ4; Survey Q7)

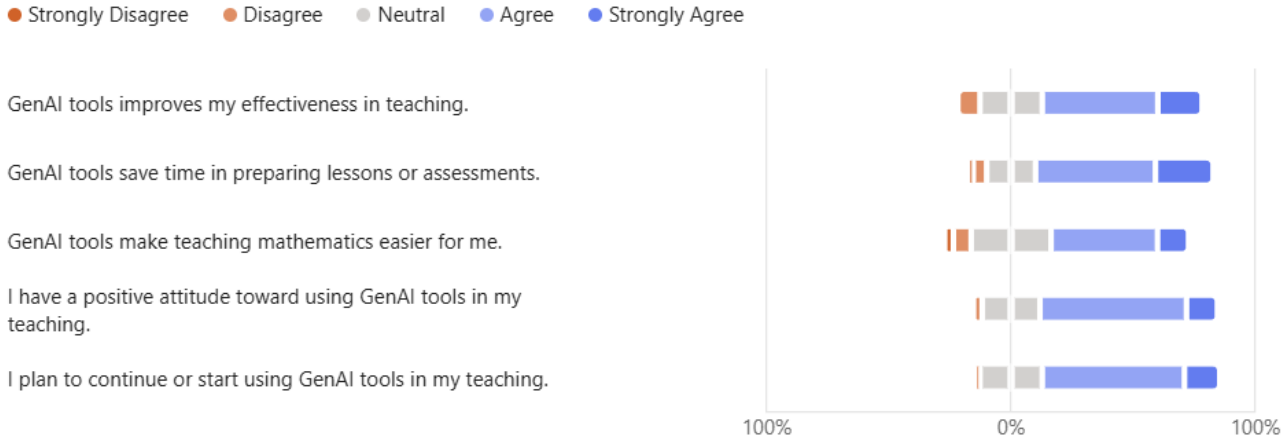

Figure 4. Responses to acceptance items (Q7), showing faculty attitudes toward and intentions to use GenAI in mathematics teaching.

Acceptance of GenAI was assessed using five items measuring perceived usefulness, ease of use, attitudes, and intention to use GenAI tools (see Figure 4). Overall, the findings indicate high levels of acceptance among participants. Most faculty expressed positive attitudes toward GenAI and reported intentions to continue or expand its use, particularly in relation to improving teaching efficiency and supporting instructional tasks. For example, around two-thirds of participants agreed that GenAI improves teaching effectiveness and saves time in lesson preparation, suggesting that these tools are already perceived as valuable in practice.

However, this high level of acceptance should be interpreted with caution, as it does not necessarily reflect strong confidence in the pedagogical use or reliability of these tools. Rather, acceptance appears alongside a degree of uncertainty, particularly when it comes to evaluating AI-generated outputs and integrating them effectively into teaching.

To address RQ4, Spearman's correlation analysis showed that acceptance was significantly associated with AI literacy ($\rho = 0.378$, $p = .004$), intelligent TPACK ($\rho = 0.558$, $p < .001$), and perceived trust ($\rho = 0.574$, $p < .001$). These findings suggest that sustained and meaningful adoption of GenAI depends not only on positive attitudes toward the technology, but also on faculty confidence in evaluating and integrating these tools effectively within teaching practice.

Responses to the open-ended questions provide additional insight into how faculty are engaging with GenAI in practice. Among the responses that provided sufficient detail for interpretation, several recurring themes emerged. Some responses were brief or general in nature and were therefore not included within the main thematic categories discussed below.

The most common theme involved instructional preparation, including lesson planning, generating teaching materials, and designing assessments, with participants noting that GenAI can reduce workload and support efficient content creation. One participant specifically described using GenAI for "lesson planning and step-by-step solutions of any problem." A second theme focused on the use of GenAI to simplify complex mathematical concepts, for example by generating step-by-step explanations, visual representations, and personalised learning materials. One participant explained that ChatGPT was useful for constructing comparisons between mathematical concepts, such as differentiation and integration, by presenting similarities and differences visually on a single page. The same participant also described using ChatGPT to connect complex mathematical topics to real-life situations, including generating visual explanations for mathematical induction by illustrating the base case and inductive step through practical examples. These responses suggest that some faculty are beginning to explore more pedagogically meaningful applications of GenAI.

A smaller group emphasised the importance of cautious and limited use, particularly at the undergraduate level, highlighting that GenAI should function as a supportive "co-teacher" rather than a replacement for instruction. This perspective reflects an awareness of both the potential and limitations of these tools.

Concerns raised by participants further reinforce this cautious approach. Faculty frequently highlighted issues related to the accuracy of AI-generated mathematical outputs and the risk of student over-reliance. Several participants noted that GenAI can sometimes generate incorrect or misleading explanations or solutions, particularly for multi-step mathematical problems, and therefore emphasised the importance of carefully verifying AI-generated content before using it in teaching. Participants also expressed concern that some students may rely on AI-generated answers without fully understanding the underlying mathematical concepts, particularly when using tools such as ChatGPT as shortcuts for completing assignments. As a result, respondents stressed the importance of emphasising mathematical reasoning and problem-solving processes rather than

focusing solely on final answers. In addition, a small number of participants highlighted concerns regarding unequal student access to AI tools and digital devices outside the classroom. These concerns align with earlier findings on perceived trust and help to explain why high acceptance coexists with uncertainty. Overall, the results suggest that faculty are willing to adopt GenAI, but expect its use to be guided by careful evaluation, pedagogical consideration, and appropriate instructional practices.

4. Discussion and conclusions

This study provides evidence that university mathematics faculty in Saudi universities are actively engaging with generative artificial intelligence (GenAI) and recognise its potential to support teaching. While acceptance is generally high, confidence in evaluating AI-generated outputs and integrating these tools pedagogically remains uneven, reflecting a gap between functional use and deeper instructional understanding.

These findings are consistent with established perspectives on technology adoption, particularly the Technology Acceptance Model (Davis, 1989), which emphasises perceived usefulness as a key driver of adoption, while more recent research highlights the importance of AI literacy, pedagogical knowledge, and trust in shaping meaningful integration of AI in education (Laupichler et al., 2022; Nazaretsky et al., 2022). Together, these factors appear central to moving beyond surface-level use toward more effective and informed practice, extending prior studies by showing how these factors interact specifically within mathematics instruction.

Although the study is situated within the Saudi higher education context, the results reflect broader challenges associated with the rapid adoption of AI in teaching, suggesting relevance beyond this setting. Overall, the study contributes to the growing body of research on GenAI in education by providing empirical insight into faculty perspectives and identifying key areas for professional development and future research. It also highlights the need for structured support to ensure that GenAI is integrated in ways that enhance, rather than replace, meaningful mathematical learning.

4.1 Concluding remarks

This study examined the use of Generative AI in university-level mathematics teaching within Saudi higher education during the 2024–2025 academic year, capturing faculty perspectives on its opportunities and challenges. Participants represented a range of teaching contexts, including mathematics departments and service courses in engineering, computing, and the sciences. Although the study involved a relatively modest sample, it was intended as an exploratory investigation of current faculty perceptions and practices relating to GenAI use in mathematics instruction.

A key limitation of the study is that the findings are based on self-reported data and may not fully reflect actual classroom practices or the full diversity of institutional contexts. Future research involving a broader range of institutions and departments would provide a more comprehensive understanding of GenAI adoption, alongside further investigation into how institutional policies and professional development can support effective and responsible integration of GenAI in mathematics education.

5. Appendix

The survey questions are given below.

2. Courses taught in the academic year 2024-2025 (Select all that apply):

- A first course in Linear Algebra
- A first course in Calculus
- Discrete Mathematics
- Other (Please specify)

3. Which GenAI tools have you used? (Select all that apply):

- ChatGPT
- Wolfram Alpha
- Symbolab
- Mathway
- Other (Please specify)

4. AI Literacy

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

- I can identify GenAI tools relevant to teaching mathematics (e.g., ChatGPT).
- I know how to use GenAI tools to support solving mathematical problems.
- I am confident in evaluating the accuracy of AI-generated mathematical solutions.
- I can guide students in responsibly using GenAI tools for learning mathematics.

5. Intelligent TPACK

- I can effectively integrate GenAI tools into my teaching of mathematical concepts.
- I know which GenAI tools are best suited for teaching specific mathematics topics.
- I help colleagues explore how to use GenAI tools in our teaching.
- Using GenAI improves how I explain difficult mathematical concepts.
- GenAI tools help me create engaging mathematics learning activities.

6. Perceived Trust

- I trust GenAI tools to provide accurate solutions.
- I believe GenAI tools are reliable for supporting mathematics teaching.
- I am concerned about bias or errors in AI-generated solutions.

7. Acceptance

- GenAI tools improve my effectiveness in teaching.
- GenAI tools save time in preparing lessons or assessments.
- GenAI tools make teaching mathematics easier for me.
- I have a positive attitude toward using GenAI tools in my teaching.
- I plan to continue or start using GenAI tools in my teaching.

8. Recommendations

Can you share any recommendations for using GenAI to support teaching mathematics? (e.g., benefits or future use)

9. Challenges

Any concerns or challenges with GenAI that colleagues should know? (e.g., issues you've faced or things to avoid)

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