Students' Perceptions of AI Use in Mathematics Learning: Opportunities for Supporting Problem-Solving Skills

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Abstract. The rapid expansion of artificial intelligence is evident in both everyday life and scientific and technological domains. In higher education, students increasingly rely on AI-based tools in a wide range of learning activities, including the study of mathematics, which plays a fundamental role in engineering education. This trend raises important questions regarding how artificial intelligence is used during the learning process and how its application may influence students' approaches to problem-solving. The paper builds on the results of a survey involving approximately 250 first-year engineering students at the University of Miskolc. The survey aims to provide an overview of students' general patterns of artificial intelligence use, as well as their AI-related practices in the context of mathematics courses. Rather than seeking to identify causal relationships, the survey serves as a starting point for an overview-oriented analysis. Based on the identified usage patterns, the paper examines methodologically grounded and intentional ways in which artificial intelligence can be integrated into problem-solving processes.

Keywords: AI, Engineering education, Problem-solving skills

1 Introduction

Problem-solving competence plays a central role in engineering education because it provides the foundation for effective professional practice. Engineering tasks are rarely well-defined and often require approximation, judgment, and the ability to deal with uncertainty, demanding a higher level of reflective thinking than that associated with well-structured problems [1]. In their study [2], T. Litzinger and his co-authors argued that engineering education should include learning processes that support the confident application of key technical and professional skills, as well as the use of problem-solving in authentic engineering projects. According to the authors, traditional teaching methods are often not well aligned with these objectives.

As artificial intelligence becomes increasingly integrated into engineering education and professional practice, it is essential that students remain active participants in the

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thinking process rather than passive users who follow automatically generated solution patterns.

Without reflective engagement, there is a risk that reliance on AI-based tools may lead to superficial understanding and reduced cognitive involvement. Therefore, educational approaches should promote deliberate AI use that encourages students to question, verify, and critically evaluate AI-generated responses rather than accepting them uncritically [3]. These considerations are already highly relevant in foundational courses, including mathematics, where problem-solving is not merely about obtaining correct results but about developing structured reasoning, abstraction skills, and strategic thinking. For this reason, special emphasis must be placed on the deliberate use of artificial intelligence. Instead of relying on uncontrolled solution-generating algorithms, AI should be applied in ways that support long-term learning goals, foster students' cognitive development, and strengthen their ability to analyze, evaluate, and construct problem-solving strategies independently. Numerous studies (e.g. [4] – [8]) suggest that artificial intelligence is more likely to support the development of problem-solving competencies when students remain active and reflective participants in the learning process, and when technology serves to support rather than replace cognitive engagement.

The survey conducted among engineering students, which forms the basis of this paper, also confirmed that most students adopt a critical attitude toward the use of artificial intelligence. Rather than viewing AI as a replacement for the learning process, they generally regard it as a supportive tool that can enhance learning while preserving the importance of their own understanding, reasoning, and active participation. Several recent studies (e.g. [9], [10]) have reported similar results, indicating that most students perceive artificial intelligence as a valuable tool for supporting learning rather than replacing it. At the same time, they continue to emphasize the importance of interaction with instructors, independent cognitive engagement, and the maintenance of critical thinking and evaluation skills.

In line with these findings, this paper argues that engineering education - particularly in foundational courses - should emphasize teaching the deliberate and methodologically grounded use of artificial intelligence. Such an approach may not only positively influence short-term academic performance but also foster the development of long-term problem-solving and thinking competencies that are essential in rapidly evolving, AI-enriched engineering practice.

Although numerous studies have examined students' attitudes toward AI, fewer studies have focused specifically on its use in mathematics learning among engineering students and on the educational implications for supporting problem-solving processes. Therefore, the aim of this study was to explore engineering students' patterns of AI use in mathematics learning, their perceptions of AI-assisted learning, and the educational implications of these findings for supporting problem-solving processes.

2 Questionnaire Survey

2.1 Methodology

In the autumn semester of 2025, a targeted survey was conducted among first-year undergraduate students at the University of Miskolc, Hungary. The primary objective of the study was to explore students' patterns of artificial intelligence use in learning, with particular emphasis on mathematics education. The survey also aimed to investigate students' perceptions of how generative artificial intelligence influences the learning process, as well as to identify the benefits and potential drawbacks associated with the use of AI-based tools in educational settings. The study focused on first-year engineering students because their secondary school mathematics learning coincided with the widespread emergence of generative AI tools, making them particularly suitable for investigating current AI usage patterns in higher education.

The questionnaire was developed based on previous studies investigating students' perceptions and use of artificial intelligence in higher education (e.g. [10], [11]), while several items were adapted to the context of mathematics learning. To encourage participation while maintaining the quality of responses, the questionnaire was designed to be concise and focused, requiring approximately 10 minutes to complete.

Data were collected anonymously through the Microsoft Forms platform. A total of 252 first-year BSc students participated in the survey. The survey was organized into six thematic sections that reflected the progression of students' experiences with AI in mathematics learning. It first explored their everyday use of AI tools, followed by their experiences with AI-assisted mathematics learning in secondary school and university. The questionnaire then examined students' trust in AI-generated mathematical solutions, their perceptions of the educational benefits and potential risks of AI-assisted learning, and their views on the future role of artificial intelligence in university mathematics education. Attention was paid to comparing students' experiences of AI use in secondary school mathematics and university mathematics courses, allowing changes in AI usage patterns and attitudes between the two educational levels to be explored.

The questionnaire contained mainly closed-ended questions, including multiple-choice and Likert-type items, complemented by one optional open-ended question allowing students to provide additional comments. This structure enabled a quantitative description of students' response patterns and the collection of qualitative feedback regarding AI-assisted mathematics learning.

The collected data were analyzed using descriptive statistics. Frequencies and percentages were calculated for each questionnaire item to characterize students' AI usage patterns, perceptions, and attitudes toward AI-assisted mathematics learning.

2.2 Results

General Use of Artificial Intelligence. The findings indicate that artificial intelligence has become an integral part of first-year students' everyday digital environment. Out of the 252 respondents, 226 students (89.7%) reported using generative AI tools in their everyday activities, while only 26 students (10.3%) indicated that they did not use such

technologies. These results suggest that many students enter higher education with prior experience of AI-based applications, making AI literacy an increasingly important consideration in university teaching.

The survey also explored students' familiarity with specific AI-based applications. As shown in Figure 1, ChatGPT was almost universally recognized (245 students), followed by Gemini (178 students) and PhotoMath (157 students), while awareness of more specialized mathematical applications such as WolphramAlpha, Microsoft Math Solver, and Solvely was considerably lower. This indicates that students primarily rely on widely accessible conversational AI systems rather than discipline-specific mathematical software.

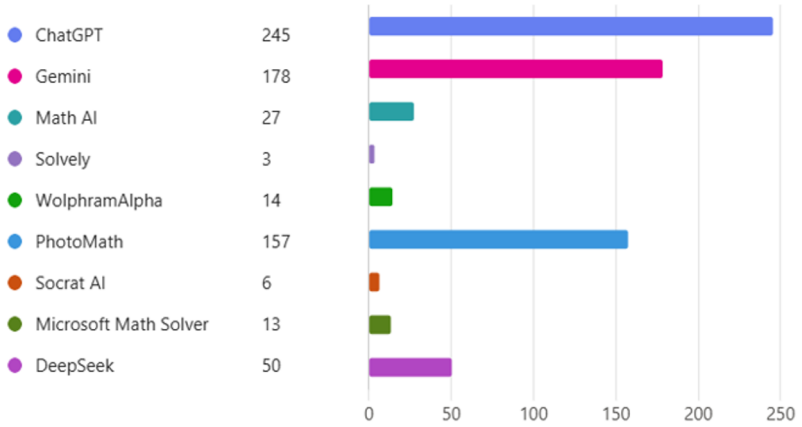


Fig. 1. Students' familiarity with AI-based tools.

AI Use in Mathematics Learning. The results demonstrate that AI is used extensively for mathematics learning both before and after entering university. During secondary school, 138 students (54.8%) reported using AI-supported tools for learning mathematics. This proportion increased markedly at university, where 217 students (86.1%) indicated that using AI-based tools or mathematical problem-solving applications during their university mathematics studies, while only 35 students (13.9%) reported not using them.

The substantial increase in AI use after students entered higher education suggests that university mathematics creates a stronger demand for supplementary learning support. Compared with secondary school, university mathematics typically requires more abstract reasoning, and more intensive self-study making AI-assisted learning resources particularly attractive.

The purposes for which students used AI also reflected its educational role. In university mathematics, AI was used primarily to prepare for examinations (172 responses) and to deepen understanding of topics covered during classes through independent practice (153 responses). These findings suggest that students mainly perceive AI as a supplementary learning resource rather than merely a tool for obtaining answers.

The survey also examined which AI applications students used most frequently in mathematics courses. Figure 2 shows that ChatGPT was by far the most widely used tool, followed by Gemini and PhotoMath.

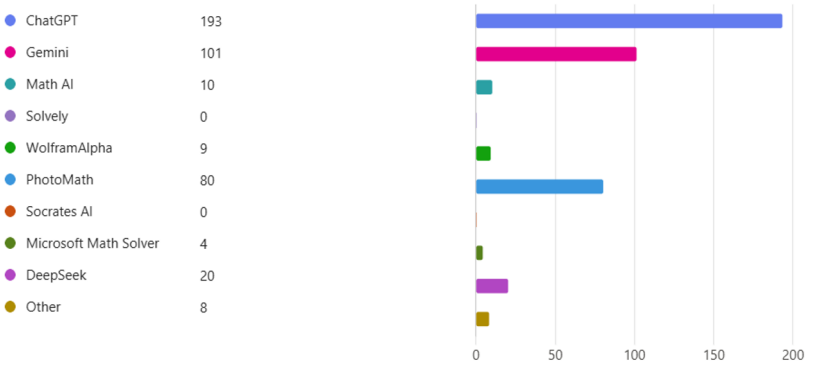


Fig. 2. Frequency of use of AI-based tools and mathematical problem-solving applications among students during university mathematics studies.

The considerably lower use of specialized mathematical software again indicates that students prefer versatile generative AI systems capable of providing explanations alongside mathematical solutions, rather than simply performing symbolic computations.

Trust in AI-Generated Mathematical Solutions. Students generally viewed artificial intelligence as a useful aid in mathematical problem solving. When asked whether AI could support the more efficient solution of mathematical problems, 122 respondents (48.4%) answered "Yes", while 128 students (50.8%) selected "Maybe". Only two respondents (0.8%) rejected this possibility. These results demonstrate an overwhelmingly positive attitude toward the educational potential of AI technologies.

Despite recognizing the usefulness of AI, students expressed a more cautious attitude regarding the reliability of AI-generated solutions. Most respondents reported moderate rather than unconditional trust in AI systems. A total of 186 students (73.8%) selected "Rather yes" when asked whether they trusted AI-based tools to solve mathematical problems correctly, while 60 students (23.8%) selected "Rather no". Only six respondents (2.4%) indicated complete trust in AI-generated solutions.

The survey further revealed that this cautious attitude is supported by students' own experience. Among those who had used AI for mathematics learning, 201 respondents reported having encountered at least one incorrect AI-generated solution or erroneous mathematical derivation. Only 16 students reported never observing such errors. The widespread recognition of AI inaccuracies suggests that students do not accept AI-generated solutions uncritically but are generally aware of the limitations of current AI systems.

Taken together, these findings indicate that students clearly distinguish between the usefulness and the reliability of artificial intelligence. Although they generally consider

AI an effective learning aid, they remain aware that AI-generated mathematical solutions require critical evaluation and independent verification.

Perceived Benefits and Risks of AI-Assisted Mathematics Learning. The questionnaire also explored students' perceptions of the educational benefits of AI-assisted mathematics learning. As shown in Figure 3, students perceived the greatest educational benefit of AI in providing step-by-step mathematical solutions (206 responses). Many students also highlighted its potential to support personalized learning (107 responses) and improve conceptual understanding (103 responses), while interactive learning materials were mentioned considerably less often. These findings suggest that students primarily value AI as an explanatory learning tool that facilitates understanding rather than simply producing final answers.



Fig. 3. Perceived ways in which AI can support students in learning mathematics.

At the same time, respondents were aware of several potential disadvantages associated with AI-assisted learning. The most frequently identified concern was excessive dependence on technology (160 responses), followed by the possible decline of critical thinking skills (134 responses) and reduced human interaction during the learning process (90 responses). Only a small proportion of students reported that they saw no disadvantages in the educational use of AI.

Overall, the results indicate that students adopt a balanced perspective toward AI-assisted mathematics learning. While they clearly recognize its educational benefits, they are also aware of the importance of maintaining independent mathematical thinking and avoiding excessive reliance on AI technologies.

Integration of AI into University Mathematics Education. The survey examined students' attitudes toward integrating AI-based tools into university mathematics teaching. When asked whether AI should be incorporated as a supplementary teaching method, 92 students (36.5%) answered "Yes," while 118 respondents (46.8%) selected "Maybe." Only 42 students (16.7%) rejected the idea.

Although fewer than half of the respondents explicitly supported the integration of AI into university mathematics education, the large proportion selecting "Maybe" indicates cautious openness rather than resistance. These findings indicate that students are generally open to the educational use of AI, provided that it complements rather than replaces traditional teaching approaches.

Future Role of AI in Mathematics Education. A particularly important finding concerns students' views on the future role of artificial intelligence in university mathematics education. As illustrated in Figure 4, most students rejected the idea that AI could replace traditional mathematics teaching. More than two-thirds of respondents (71.4%) believed that AI should primarily be used as a supplementary learning tool. Only a small minority support the complete replacement of conventional teaching methods. 48 students (19.0%) believed that AI could partially replace certain aspects of current instruction. Only 10 students (4.0%) considered that AI could completely replace university mathematics education, while 14 students (5.6%) saw no need for AI-based tools in mathematics learning.

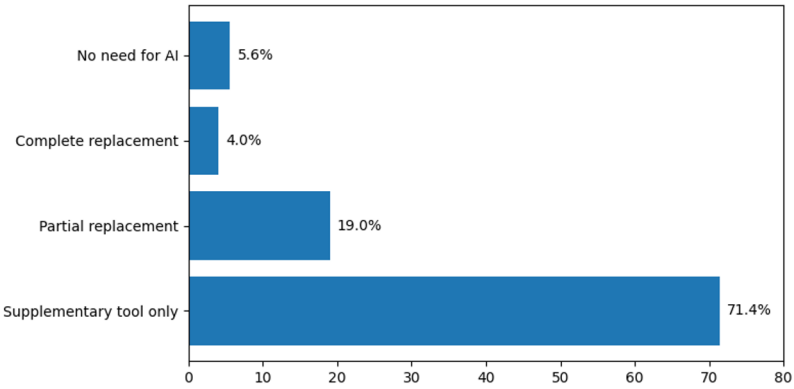


Fig. 4. Students' perceptions of the future role of AI in mathematics education.

These findings demonstrate that students perceive artificial intelligence primarily as a technology that enhances rather than replaces mathematics education. Although AI applications are widely used and are considered helpful by most students, they still recognize the value of instructor guidance, classroom interaction, and independent mathematical reasoning as fundamental components of effective learning. The results therefore indicate that students view AI as an additional educational resource that can enrich mathematics instruction. At the same time, they continue to regard teachers as essential for explaining concepts, guiding learning, and fostering mathematical reasoning.

3 Supporting Mathematical Problem-Solving Through Deliberate AI Use

The questionnaire results indicate that students generally perceive artificial intelligence as a valuable resource for learning mathematics. At the same time, their moderate trust in AI-generated solutions and their experience with incorrect outputs highlight the importance of critical evaluation and independent mathematical thinking. The educational challenge, therefore, is not simply whether students should use AI, but how they can

use it in ways that support rather than replace their own problem-solving processes. This calls for an approach that integrates AI into mathematics education while keeping students actively involved in understanding, planning, solving, and evaluating mathematical problems. In this context, Pólya's problem-solving model provides a useful framework for considering where and how AI can support the problem-solving process without taking it over.

Effective mathematical problem solving involves considerably more than obtaining correct answers. According to Pólya [12], successful problem solving requires understanding the problem, developing an appropriate solution strategy, carrying out the solution, and evaluating the obtained result. Similarly, Schoenfeld [13] emphasized that successful mathematical problem solving depends not only on procedural knowledge, but also on metacognitive regulation, strategic decision-making, and continuous monitoring of one's own thinking. Therefore, the value of educational technologies lies in how effectively they support students' mathematical reasoning and problem solving, rather than in their ability to generate solutions.

Recent research on generative artificial intelligence has reached similar conclusions regarding the educational use of AI. Several studies argue that AI contributes positively to learning only when students remain actively engaged in evaluating, interpreting, and questioning AI-generated outputs rather than accepting them uncritically [4,6,14,15]. Excessive reliance on AI-generated solutions may encourage cognitive offloading, reducing learners' cognitive engagement and limiting opportunities for developing conceptual understanding and independent reasoning [3]. Conversely, when AI is integrated into reflective learning activities, it can support mathematical reasoning by encouraging students to compare alternative solutions, identify errors, justify mathematical arguments, and reflect on their own thinking processes [5, 6, 15].

From the perspective of Pólya's framework, AI can support students throughout the different phases of mathematical problem solving without replacing their own thinking. Table 1 presents examples of how AI can facilitate each phase of the problem-solving process while fostering mathematical reasoning and reflective learning.

As illustrated in Table 1, AI can contribute to every stage of mathematical problem solving. However, its educational value depends on how it is used. Activities that require students to justify AI-generated suggestions, compare alternative strategies, or evaluate the correctness of proposed solutions encourage active engagement with mathematical ideas rather than passive acceptance of answers. In this way, AI can support the development of mathematical reasoning, metacognitive skills, and self-regulated learning, which are fundamental components of successful problem solving.

These examples illustrate that the educational value of AI lies not in providing immediate answers but in supporting the reasoning processes that characterize successful mathematical problem solving. When used in this way, AI becomes a resource for promoting reflection, strategic thinking, and self-regulated learning rather than a substitute for students' cognitive effort. Such an approach is closely aligned with inquiry-based mathematics education, where learning is driven by questioning, exploration, and justification instead of memorizing procedures or reproducing solutions.

This approach is particularly relevant in engineering education, where mathematical problems are often open-ended and require selecting appropriate methods, evaluating

assumptions, and interpreting results rather than simply applying standard algorithms. As AI becomes an increasingly integral part of engineering practice, engineering education should prepare future engineers to use AI tools effectively, critically evaluate their outputs, recognize potential errors, and make well-founded professional decisions. Accordingly, mathematics education should provide opportunities for students to learn how to integrate AI into mathematical problem solving in a critical and reflective manner, thereby preparing them for AI-supported engineering practice.

Table 1. Integrating AI into mathematical problem solving process.

Problem-solving phase (Pólya)	Possible AI support	Competences developed
Understanding the problem	Explaining mathematical concepts, interpreting the problem statement, identifying relevant information, visualizing the problem	Conceptual understanding
Planning a solution	Suggesting alternative solution strategies, suggesting applicable theorems or methods, comparing different approaches	Strategic thinking and decision making
Carrying out the solution	Checking intermediate steps, identifying computational errors, explaining individual solution steps	Procedural accuracy and mathematical reasoning
Evaluation	Verifying results, comparing alternative solutions, exploring generalizations, and analysing the effects of changing the problem conditions	Critical evaluation, reflection and transfer of knowledge

4 Conclusion

Overall, the survey results demonstrate that AI technologies have become an integral part of mathematics learning among first-year university students. Students generally perceive these tools as useful and potentially beneficial for problem solving; however, they also acknowledge their limitations and report frequent encounters with incorrect AI-generated solutions. The combination of widespread adoption, moderate trust, and awareness of potential errors suggests that future educational approaches should focus on developing students' ability to use AI critically and responsibly rather than discouraging its use altogether.

Building on the observed combination of widespread AI use, perceived usefulness, moderate trust, and students' awareness of potentially incorrect AI-generated solutions, we propose a framework that illustrates how AI can support different phases of the mathematical problem-solving process as part of well-designed learning activities. By

relating the capabilities of AI to Pólya's problem-solving framework, we demonstrate that AI can contribute not only to solving problems but also to developing students' mathematical reasoning, reflection, and strategic thinking.

The proposed framework is particularly relevant for engineering education, as AI-supported tools are becoming an integral part of engineering practice. Mathematics education should therefore prepare students to use these technologies effectively, evaluate AI-generated solutions critically, and make informed decisions when solving engineering problems.

The findings should be interpreted in light of some limitations. The survey was conducted among first-year engineering students at a single institution and relied on self-reported data; therefore, the results should not be considered representative of engineering students in general. Nevertheless, the findings provide useful insight into current AI usage patterns and can serve as a basis for further research on the pedagogical integration of AI in mathematics education.

Future research should examine how AI-supported learning activities influence students' mathematical problem-solving competence in authentic educational settings and how these effects evolve throughout engineering studies.

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