

Development of Mathematical Reasoning through AI-Based Learning Platforms

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Abstract: *Artificial Intelligence (AI) has been playing an increasingly important role in the current educational processes, specifically in the context of mathematics learning. Although learning platforms based on AI are becoming increasingly popular, their particular contribution to the development of mathematical reasoning in the era of artificial intelligence has not been thoroughly studied yet. Thus, the current research intends to investigate the role of AI-based learning platforms in the acquisition of logical thinking, understanding concepts, and problem solving in mathematics education. The research is qualitative in design as it applies the method of thematic analysis and data were gathered by analyzing documents and digital contents concerning AI-based mathematics learning systems, such as AI-generated explanations, step-by-step problem solving, and the adaptive feedback systems. The evaluation of the results found some major concepts like support of logical reasoning, structured guidance to solve problems, conceptual clarity, adaptive feedback, and interactive learning engagement. Such results show that AI-based platforms can provide a well-structured learning environment, which facilitates critical thinking and better comprehension of mathematical ideas. The research comes to the conclusion that there is a significant potential of AI-based learning platforms to improve the development of mathematical reasoning in a modern digital learning setting.*

Keywords: Mathematical reasoning, Reasoning development, Artificial intelligence, Learning platforms

1. Introduction

The fast development of the artificial intelligence has radically changed the sphere of education, especially the teaching and learning of mathematics. Within the past few years, AI-powered learning platforms became viable instruments that help facilitate personalized learning, adaptive feedback, and interactive problem-solving platforms. These technologies are also being incorporated into the education systems to improve cognitive abilities of students and to make them understand mathematical concepts more profoundly. Mathematical reasoning, being a form of logical thinking, recognition of patterns, conjecturing, justification as well as drawing valid conclusions based on the information presented to the person, is one of the most significant areas of mathematics learning that can be impacted by such technologies.

Reasoning based on mathematics is central to the acquisition of higher order thinking and has been termed as a primary prerequisite in mathematics education. It allows learners to go beyond memorising formulas and procedures into learning more conceptual relationships about mathematics. Nevertheless, the conventional ways of teaching usually focus on procedural knowledge but overlook reasoning and analytical thinking. Consequently, most students find it difficult to come up with good reasoning skills, and thus, they are not capable of using mathematical knowledge in practical setting.

New opportunities have been created by the introduction of AI-based learning platforms this allows to resolve this challenge. The platforms employ machine learning algorithms, intelligent tutoring systems, and data-based analytics to provide individualized learning to students. Through the analysis of the feedback of students, their learning rate, and the ways they solve problems, AI systems can be used to provide them with immediate feedback, tailored guidance and learning scaffolds. These features will

stimulate students to think, find various solutions and rationalize their thoughts. AI-modified patterns of learning platforms contain gamified learning features, dynamic problem sets, and interactive simulations to present mathematics more interesting and all accessible. These tools have the ability to lead students into reasoning processes in stages and hence they not only know the correct answer, but also the logical steps to be taken in seeking the correct answer. As a result, artificial intelligence learning systems can lead to a better level of mathematical knowledge and reasoning skills.

Cho and Kim (2025) aimed to find the function of AI-organized learning platforms in individualized learning in the context of mathematics. The three main AI-based educational platforms on mathematics were examined with the help of the framework relying on four dimensions: source, target, time and adaptation method. To be more specific, this paper was concerned with the aim of providing examples illustrative of each of the dimensions to learn about the potential of such platforms to facilitate individual mathematics learning in the classroom. The findings also indicated that all the three platforms utilized a diverse array of factors as the sources of adaptation to achieve personalized learning in mathematics. They also took a two-path way strategy of deciding when to adapt and a shared-controlled strategy of how to adapt. The platforms differed with regard to what they should adapt in terms of their content, the way of presentation, as well as the level of instructional support. However, KnowRe Math and ALEKS lacked the ability to be flexible with regard to format of presentation. In accordance with these results, the implications of applying AI-based systems to personalized mathematics learning in the classroom to educators are addressed (Cho & Kim, 2025). A study was conducted by Vintereis et al. (2024) to determine the type of artificial intelligence-based platforms used by students taking undergraduate engineering mathematics courses, to elicit the users-students and teachers experience of using them and to conduct a comparative analysis of two countries-Latvia and

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Estonia in the journey to identifying the challenges and considerations of using artificial intelligence-based mathematics learning platforms in the process of undergraduate engineering mathematics studies. The purpose of the study is to identify what kind of artificial intelligence-based platforms are used by students taking undergraduate engineering. The research activities will involve the identification of AI-based mathematics learning platforms including Photomath, Desmos, GeoGebra, Maplesoft, Matific, Carnegie Learning, Microsoft Math Solver, ASSISTments, Fiscal Calculator and chatbot ChatGPT and the discussion of the scientific literature on the advantages of the application in mathematics studies. Empirical studies involve a survey of the undergraduate students in both nations as well as a concentrated interview of the teaching personnel. According to the research findings, Photomath, chatbot chat GPT and Symbolab are the most heavily used tools in both countries, with GeoGebra (Estonia) and Desmos (Latvia) being second (Vintereis et al., 2024). Junaid & Javaid (2025) discuss the effectiveness of AI-concept mapping in improving the mathematical reasoning, problem solving, and student participation in collaborative and individual learning practices. Using multimodal semiotic reasoning, learners may have a means to connect abstract mathematical ideas with visual, textual, and interactive displays to allow learners a more comprehensive grasp of the subject. The study takes the mixed-method approach, which will involve the quantitative measurement of performance and the qualitative input of teachers and learners. The initial results indicate that AI-driven concept mapping has an advantage to metacognitive knowledge, error detection, and differentiated teaching. Additionally, the use of AI will make this personalized learning experience possible and scalable, as well as accessible in various learning environments. Nevertheless, the issues of algorithmic bias, data confidentiality, and the digital divide are also important factors to take into account. The present research can be integrated into the changing discussion of AI in education as it shows that it can be used to improve conceptual learning and problem-solving in mathematics (Junaid and Javaid, 2025).

A study by Soesanto et al. (2022), which is based on cross-section design and phenomenological method, examines the perception of senior high school students of AI-based learning, especially their perception and recommendation of AI-based learning in mathematics in the post-pandemic situation. The study population included 107 students who were in various islands of Indonesia and were in the grades the 10-12 with an age of 15-18 years. The questionnaires containing open-ended questions in the form of Microsoft forms that were sent to mathematics teachers who were members of several WhatsApp groups were used as the instruments. Data analysis was done in a multistage descriptive and pattern coding. It was found that AI should be facilitated to students to enable them to see understandable visualization and guide them to solve mathematical problems. One can anticipate that the current research results can provide scholars in Indonesia and other countries with opportunities to spread and/or adopt AI learning in the shape of Intelligent Tutoring Systems (Soesanto et al., 2022). Casanova et al., (2025) present Smart Math AI as a tool in education, which incorporates a virtual tutor that is powered by artificial intelligence and combines it with the Problem-

Based Learning (PBL) approach. The main goal of the application is to help people master the Pythagorean theorem by providing them with a personalized learning process. This is made possible through providing interactive activities, instant feedback, and tracking progress to the students. The applications include exercises to enable the learner to practice on the interaction with a virtual tutor. The tutor gives feedback based on the needs and progress of the learner hence influencing him/her through learning. A study was applied to junior high school students to measure its effectiveness through pre- and post-tests and also using perception survey. The findings indicated that the learning level was significantly improved with great motivation and acceptance that such technologies should be used in the classroom. The conclusion is made that the incorporation of generative language models into the educational environment can enhance the learning of mathematical skills, promote critical thinking, and make students more motivated, which justifies the adoption of AI-assisted PBL in schools (Casanova et al., 2025).

Although AI technologies in the field of education are increasingly becoming a part of the educational process, there is still a gap in the systemic research on how AI technologies can influence the process of development of mathematical reasoning. Although a few studies demonstrate the positive effect of AI assisted learning in enhancing academic performance, they have not paid much attention to the effect these platforms have on the reasoning capabilities and conceptual learning in mathematics among students. But highlighting the correlation is important to develop AI-based tools and techniques of learning and teaching. Consequently, this current research will focus on the issue of AI-based learning systems and their place in improving mathematical reasoning in learners. Through the analysis of the effects of AI-based learning environments on the reasoning process of students, the level of their engagement, and the way they approach solving problems, the research aims to add to the current body of scientific knowledge regarding the application of artificial intelligence in mathematics education. The results of this research can offer important implications to teachers, scholars, and educational technology professionals who wish to use AI technologies to enhance mathematical learning results and develop critical thinking abilities in learners.

2. Statement of the Problem

Although the use of AI-based learning platforms in mathematics is becoming increasingly popular, the effectiveness of such platforms in the development of mathematical reasoning in students is not well studied. Logical thinking and conceptual understanding continues to be a problem with many learners. Thus, there is a need to look into the role of AI-assisted learning environments in the process of developing mathematical reasoning skills.

3. Research Objectives

The current research project will focus on discussing how AI-based learning tools can be used to develop the mathematical reasoning skills of students. In particular, the following objectives of the study are:

- 1) To investigate how AI-based learning platforms can be integrated into mathematics learning
- 2) To examine the effects of AI-based learning environments on the logical thinking and problem-solving ability of students
- 3) To measure how effective AI-based platforms will improve the mathematical reasoning of students
- 4) To determine the possible opportunities and limitations related to the use of AI technologies in learning mathematics.

These objectives are aimed at developing an insight on how artificial intelligence could be connected with the further conceptual knowledge and reasoning in mathematics education.

4. Research Methodology

The current research will take qualitative research with the application of thematic analysis to explore the role of AI-based learning platforms in the growth of mathematical reasoning in mathematics instruction. Rather than using human participants, the research utilizes document analysis and digital content analysis of AI-based learning platforms and associated learning resources on mathematics learning. The study data is gleaned through various sources, such as AI-based explanations, stepwise demonstration of problem resolution, adaptive feedback systems, and teaching material offered through popular AI-based systems of learning mathematics. Moreover, pertinent scholarly publications, reports, and academic articles on AI-assisted mathematics learning are also consulted to develop an in-depth picture of AI in the field of developing mathematical rationality.

The thematic analysis is a method of analyzing the gathered data performed in order to identify and interpret recurring patterns within the content in a systematic manner. The process of analysis involves a number of steps: acquaintance with the materials gathered, development of first codes connected to the processes of reasoning, possible topics of the data, and development of the topics with the help of constant comparison of the data.

In the process, the significant themes of logical reasoning support, step wise analytical guidance, clarification of concepts, adaptive feedback, and scaffolding of problem solving are established. These themes are useful in explaining the way mathematical reasoning can be developed within digital learning settings with the help of AI-based learning platforms.

5. Results

The thematic analysis of AI-based learning platforms and the academic literature on the subject matter demonstrated that there are a number of important themes that explain how AI-based platforms assist in the development of mathematical reasoning. The study of the content concerned the teaching design, evaluation systems, and problem-solving assistance within AI-based mathematical learning systems. Based on the coding and classification of the materials gathered, there were five broad topics, namely, logical reasoning support, step-by-

step problem solving guidance, conceptual clarity, adaptive feedback, and interaction learning on the part of the learner.

The initial theme, logical reasoning support, emphasizes the use of AI-based platforms in helping learners to make sense of the logical form of mathematical problems. Most AI systems offer solutions in a systematic order, which stimulates learners to examine associations amid variables, speculations, and inferences (White and Frederiksen, 1990). These platforms do not show end results but tend to show the process that may be in between, indicating the reasoning. This presentation is structured to assist the learners in gaining knowledge on the way mathematical arguments are developed and it promotes critical thinking.

The second name of the theme found is step by step problem solving guidance. AI-learning platforms simplify complex mathematical problems by making it in smaller steps (Lee and Yeo, 2022). Every step is supported by the explanations that explain the mathematical principles that are used. This scaffolding method enables the learners to slowly develop reasoning as they proceed through the problem solving movement (Bartelet et al., 2016). Analyzing the logical progression of every step in comparison to the last one, learners will have a better insight into the mathematical operations and will be able to explain their decisions with sound reasoning.

Conceptual clarity is another theme that is significant. The review has shown that AI-based solutions focus on conceptual explanations and procedural solutions. These platforms can offer many forms of mathematical concepts (Kumari, 2025), including symbolic expressions, graphical descriptions, and verbal descriptions. These multidimensional representation means help learners to identify abstract mathematical ideas with the help of concrete reasoning.

Adaptive feedback is the fourth theme that talks about the dynamism of AI systems in responding to the inputs of learners. Most AI-powered systems process the patterns of response given to the learner and serve a corrective feedback or hint whenever a mistake is made (Rakhmetov et al., 2025). This feedback can be used to take into account often the reason why a particular step can be wrong and propose a different reasoning strategy. These prompt responses would help the learners to reflect their reasoning and modify problem solving patterns. This means that the learners will be able to sharpen their logical reasoning in a gradual manner and become more and more reasoning.

The last theme has been determined as the engagement of the learners via the interaction learning environments. Such learning resources as interactive sets of problems (Abidin et al., 2025), simulations and guided practice exercises that promote active learning are generally part of AI-based learning platforms. These characteristics provide the learners with the opportunity to explore a variety of methods of tackling problems (Opesemowo & Ndlovu, 2024). With repeated exposure to mathematical problems, the learners can apply hypotheses, test the solutions, and enhance their reasoning capacity.

On the whole, the thematic analysis indicates that the AI-based learning systems present a number of mechanisms that facilitate the emergence of the mathematical reasoning. Critical and rational thinking is promoted by the tasks. An appropriate learning environment equipped with adaptive feedback, conceptual representations, scaffolded problem-solving processes and structured explanations is also accompanied by these task. The findings imply that educational technologies with the assistance of AI can significantly contribute to the process of reasoning-based mathematics learning by enabling learners to be more advanced in their engagement with mathematical ideas and strategies of solving problems.

6. Discussion

This research was aimed at investigating the role of AI-based learning platforms in the development of mathematical reasoning in mathematics education. The study aims were deigned at investigating the role of AI-based systems in the process of learning mathematics, examining how these systems affect logical thinking and problem-solving, and determining the processes by which AI-supported systems facilitate the development of logical thinking. The results of the thematic analysis are useful findings that can be related to these goals.

The role of logical reasoning support in the AI-based learning platforms is one of the major study findings. According to the results, these platforms often demonstrate mathematical tasks in a structured manner, which brings out the logical flow of steps used in solving the problem. The given finding is directly connected with the aim of assessing the effect of AI-assisted environments on the reasoning of students. AI platforms also foster the approach whereby learners can see the logical links among various steps of a solution to learn how mathematical procedures work, as opposed to depending on memorization. The method augments development of analytical thinking which is one of the major aspects of mathematical reasoning.

One more important discovery is that AI learning systems have step-by-step instructions on how to solve a problem. The findings indicate that complicated mathematical problems are usually divided into smaller and sequential problems that simplify the reasoning process. This finding justifies the purpose of investigating the role of the AI-based learning systems in supporting reasoning-oriented learning. The systematic directions offered by AI systems can be considered the scaffolding version, as the reasoning skills of learners are developed over time. This scaffolding is especially relevant to mathematics education, where the learners frequently have the problem with the comprehension of multi-step reasoning.

Another theme that was identified in the study was conceptual clarity. The explanations given by AI-based platforms often tend to highlight the underlying mathematical ideas as opposed to directly giving procedural answers. This result indicates that AI technologies have the potential to assist the advancement of the conceptual knowledge that is closely associated with developing mathematical reasoning. When students grasp the concepts involved in mathematical operations, they can be more competent to use reasoning

when working on new and unknown problems. Therefore, the incorporation of conceptual explanations in the AI systems also plays a significant role in fulfilling the goal of the research of developing better reasoning.

Adjustive feedback is another key area that was brought out in the findings. AI-powered systems can scan user inputs and give feedback or corrective instructions in real time. This aspect is useful because it enables the learners to be aware of the faults in their reasoning and re-evaluate their methods. The theme discussion indicates how AI technology can be used to facilitate reflective learning. Quick responses also prompt the learners to rethink their logical processes and this will encourage them more to explain and prove mathematical arguments.

Last of all, the findings show that learning environments designed through AI-based platforms increase engagement among learners in solving mathematical problems. Interest activities, simulation, and guided activities encourage learners to engage in the process of learning. This kind of interaction makes experimentation and exploration possible and these are critical to reasoning development. Learners develop more confidence in using logical thinking strategies when they are exposed to mathematical problems several times. All in all, the discussion demonstrates that the themes established in the results are in high support of the research objectives of the study. AI-based learning platforms not only offer instructional support, but also the environment of learning that develops reasoning-oriented learning. The development of mathematical reasoning can be substantially improved by applying AI technologies in contemporary classrooms by means of combining systematic explanations, conceptual instruction, adaptive feedback, and interactive interaction.

7. Conclusion

The current study investigated the potential role of AI-driven learning platforms for supporting mathematical reasoning in today's digital learning environments. The significance of the study lies in investigating what role AI-assisted platforms play to enable logical thinking, conceptual understanding and structured processes of solving problems in mathematics. Through a qualitative research method, the study adopted thematic analysis to investigate AI-based instructional explanations, problem-solving demonstrations and adaptive feedback systems as integrated with the context of AI based mathematics platforms. There were multiple patterns across the analysis, which identified logical reasoning aids, guidance for solving procedures and step-by-step solutions, conceptual straightforwardness help, adaptive feedback to assist learners when they enter incorrect values or misinterpret questions and problems in a way that causes them not to arrive at a solution and interactive engagement. The structural themes are indicative of how mathematical concepts form human-usable patterns that AI-induced systems use to engender the spirit of analytical reasoning and reflective learning. The discussion essentially showed that the AI-based learning environments were actually in-line with typical objectives for which one would want students to reason more deeply and understand more conceptually mathematics. So, what is the main point coming from this paper stating about the advantages of these

tools would be in consideration under this digital world; AI empowered learning platforms, which enrich mathematics reasoning.

8. Future Research Directions

Researchers can take this work a step further by studying how other forms of AI-based learning platforms perform on different levels of learning and in different fields of mathematics. Comparative tests would be able to look into how various tools of AI affect reasoning development in fields like algebra, geometry, and calculus. It is also possible that researchers could explore the area of combining AI platforms and classroom instructional activities to develop hybrid learning solutions. Moreover, more research might utilize mixed-method design or experimental design to quantify the effect of AI-based learning on reasoning abilities of students in a more empirical manner. The discussion of ethical factors, accessibility, and readiness of teachers to integrate AI would also be helpful to guide further studies.

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