

ARTIFICIAL INTELLIGENCE AS A SOLUTION IN TODAY'S MATHEMATICS LEARNING

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Abstract

The development of *Artificial Intelligence* (AI) technology has brought significant changes in various fields, including mathematics education. The use of AI in learning has the potential to improve the quality of the learning process through providing direct feedback, personalizing learning, and increasing student engagement. However, the implementation of AI in mathematics education still faces various challenges, such as technological readiness, digital literacy, and potential dependence on technology. This study aims to analyze the influence of AI implementation on improving the competence of prospective mathematics teachers. The study used a quantitative approach with a *one-group pre-test post-test design*. The research was carried out in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Muslim Nusantara Al-Washliyah Medan by involving 35 students as a research sample. The research instruments consist of a test of understanding of mathematical concepts and a questionnaire on the perception of the use of AI that has met the criteria of validity and reliability. The results of the validity test showed that *the value of Aiken's V* was as large as the category of very valid, while the reliability test using *0,87Cronbach Alpha* obtained a value of the category as high as possible. The results of the study show that the average score of students' *0,89pre-test* increases to the *67,5482,63post-test* with a percentage increase of the results of 22,34%. *The paired sample t-test* showing a significant value $0,000 < 0,05$ that shows a significant influence of the use of AI on improving students' abilities. The findings of the study show that the implementation of AI can make a positive contribution to improving students' understanding of mathematical concepts and supporting more adaptive and interactive learning.

Keywords: *Artificial Intelligence, Mathematics Learning, Technology Integration, Prospective Teachers*

INTRODUCTION

Education is one of the important aspects in the development of quality human resources. In the era of the industrial revolution 4.0 and the transformation towards a society 5.0, education

is not only oriented to mastering knowledge, but also directed to form students' critical thinking, creativity, communication, collaboration, and digital literacy skills (OECD, 2022). In the context of higher education, especially mathematics education, the learning process is expected to be able to produce prospective educators who have adequate pedagogic, professional, social, and technological competencies so that they can adapt to increasingly rapid technological developments (UNESCO, 2023). Therefore, the mathematics learning process needs to be designed innovatively so that it not only focuses on mastering concepts, but also is able to develop high-level thinking skills and 21st century skills.

Mathematics is one of the subjects that has an important role in the development of logical, analytical, systematic, critical, and creative thinking skills of students. Mathematics learning is expected to be able to help students solve problems related to daily life and more complex problems (NCTM, 2000). However, the reality in the field shows that mathematics learning still faces various problems. Various research results show that many students have difficulty understanding mathematical concepts due to the abstract and complex nature of the material (Doorman et al, 2022). In addition, mathematics learning is still often carried out with a conventional approach that is centered on lecturers or teachers so that students tend to be passive during the learning process (Hwang et al, 2020).

The results of initial observations made on students of the Mathematics Education Study Program, Faculty of Teacher Training and Education, Muslim Nusantara Al-Washliyah University, Medan, show that some students still have difficulties in understanding mathematical concepts in depth. Students tend to memorize the problem-solving procedure rather than understanding the underlying basic concepts. In addition, the use of technology in the learning process has also not been used optimally so that learning activities are still dominated by conventional lecture methods and assignments. This condition causes student involvement in the learning process to be less than optimal.

The current development of digital technology presents various innovations that can be used to overcome learning problems, one of which is through the use of *Artificial Intelligence* (AI). Artificial Intelligence is a technology that allows computer systems to mimic human abilities to think, analyze, make decisions, and solve problems (Holmes et al, 2022). In the field of education, AI can be used to support more personalized learning through providing direct feedback, analyzing students' learning progress, and providing learning recommendations according to the needs of each individual (Chen et al, 2023).

The use of AI in mathematics education provides a great opportunity to improve the quality of learning. Several studies have shown that the implementation of AI is able to increase learning motivation, student engagement, and mathematical problem-solving skills (Zawacki-Richter et al., 2021; Chen et al., 2023). In addition, AI can also help prospective teachers develop technology-based pedagogic competencies so that they are better prepared to face learning challenges in the digital era (Luckin, 2022). However, the implementation of AI in education also faces various challenges such as limited digital literacy, educator readiness, academic integrity, and dependence on technology (UNESCO, 2023).

Based on previous research studies, most of the research focuses more on the implementation of AI on student learning outcomes, while research that examines the implementation of AI in improving the competence of prospective mathematics teachers is still relatively limited. Thus, there is a *research gap* that needs to be studied further, especially related to how the use of AI can be a solution to improve the quality of mathematics learning while strengthening the pedagogic competence of prospective mathematics teachers.

Based on this description, this study aims to analyze the use of *Artificial Intelligence* as a solution in mathematics education and examine the influence of AI implementation on improving the competence of prospective mathematics teachers in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Univeritas Muslim Nusantara Al-Washliyah Medan.

MATERIALS AND METHODS

This study uses a quantitative approach with a *one-group pretest-posttest* design to determine the effect of the implementation of *Artificial Intelligence* (AI)-assisted learning on the competence of prospective mathematics teachers. The research was carried out at the Mathematics Education Study Program, Faculty of Teacher Training and Education, Muslim Nusantara Al-Washliyah University Medan, North Sumatra, Indonesia.

The research participants consisted of 35 prospective mathematics teacher students in semesters VI and VIII who were selected using *the purposive sampling* technique based on the consideration of students who had participated in technology-based learning courses (Sugiyono, 2022).

The research instruments consisted of a test of understanding of mathematical concepts, a perception questionnaire on the use of AI, observation sheets, and interview guidelines. The validity test is performed using the validity of the content (*Content validity*) with an index of Aiken's V, namely (Aiken, 1985)

$$V = \frac{\sum S}{[n(c - 1)]}$$

Description:

- V : Validity Index
- S : $r - l_0$
- R : validator score
- l_0 : lowest score
- c : highest score
- n : number of validators

With the interval of validity as follows:

Interval	Categories
$V > 0,80$	Highly Valid
$0,60 < V \leq 0,80$	Valid
$0,40 < V \leq 0,60$	Quite Valid
$0,20 < V \leq 0,40$	Less Valid

$V \leq 0,20$	Invalid
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Meanwhile, the instrument reliability test is calculated using *the Cronbach Alpha* coefficient, namely:

$$\alpha = \left[\frac{k}{k-1} \right] \times \left[1 - \left(\frac{\sum \sigma^2 i}{\sigma^2 t} \right) \right]$$

Description:

α : Reliability Coefficient

k : Number of items

$\sum \sigma^2 i$: the number of item variances

$\sigma^2 t$: Total variance

With the interval of reliability as follows:

Interval	Categories
0,80 – 1,00	Very High
0,60 – 0,79	Height
0,40 – 0,59	Medium
0,20 – 0,39	Low
0,00 – 0,19	Very Low

Research data is collected through stages *Pre-test*, AI-assisted learning implementation, *Post-test*, observation, and dissemination of perception questionnaires. Data analysis was carried out using descriptive and inferential statistics, namely (Arikunto, 2021)

$$t = \frac{\bar{D}}{\left(\frac{SD}{\sqrt{n}} \right)}$$

Description:

t : t-value calculate

$\bar{D}$: Average Score Difference

SD : standard deviation difference

n : number of samples

If the value is significant then there is a significant influence $Sig < 0,05$.

RESULTS AND DISCUSSION

RESULTS

This section presents the results of research on the implementation of *Artificial Intelligence* (AI) in mathematics learning to improve the competence of prospective mathematics teachers. The results of the research presented include the characteristics of the respondents, the results of the validity and reliability test of the instrument, the results of the *pre-test* and *post-test* descriptive analysis, hypothesis tests, and students' perceptions of the use of AI in mathematics learning. Furthermore, the results of the study are discussed by linking relevant previous research findings to strengthen the interpretation of the results. This study involved 35 students of the Mathematics

Education Study Program, Faculty of Teacher Training and Education, Universitas Muslim Nusantara Al-Washliyah Medan, consisting of level VI and VIII students. The characteristics of the respondents by gender and semester are shown in Table 1.

Table 1. Characteristics of Research Respondents

	Quantity	Percentage
Male	11	31.4%
Women	24	68.6%
Level VI	15	42.9%
Level VIII	20	57.1%

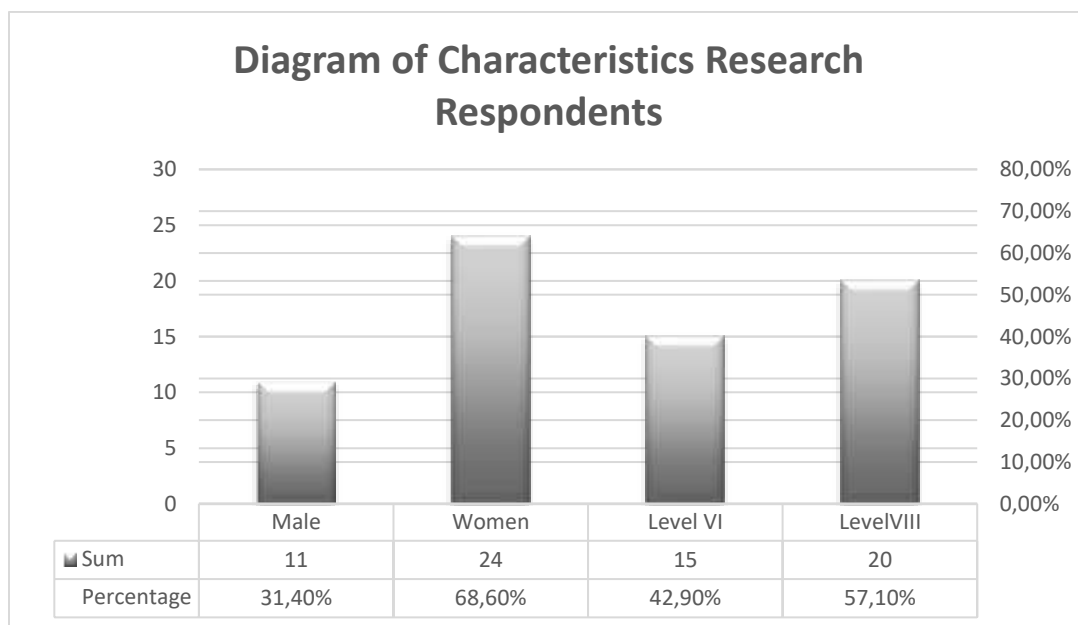


Figure 1. Diagram of Characteristics Research Respondents

Based on Table 1, the number of female respondents is more than male respondents with percentages of 68.6% and 31.4%, respectively. Meanwhile, based on the level, level VIII students have a larger number than level VI. The characteristics of the respondents showed that the research participants came from a group that had experience in mathematics learning and the use of educational technology so that they could provide an overview of the implementation of AI in mathematics learning.

Before the research instrument is used, validity and reliability testing is carried out to ensure that the instrument is suitable for use in the collection of research data. The validity of the

instrument is calculated using *the Aiken's V index* through the assessment of three experts seen in the following table 2:

Table 2. Distribution of Instrument Validation Results by Experts

Components Assessed	Validator 1	Validator 2	Validator 3	Average	Aiken's V	Categories
Compatibility of indicators with research objectives	4	5	5	4,67	0,89	Highly Valid
Clarity of instrument language	5	4	5	4,67	0,89	Highly Valid
Suitability of the material with the research variables	4	5	4	4,33	0,83	Highly Valid
Clarity of charging instructions	5	5	4	4,67	0,89	Highly Valid
Instrument format suitability	4	4	5	4,33	0,83	Highly Valid
Overall average	4,40	4,60	4,60	4,53	0,87	Highly Valid

Based on Table 2, the validation results carried out by three experts showed that all components of the instrument obtained a very valid category with an average Aiken's V value of 0,87. This value shows that the instrument used is in accordance with the research objectives, measurement indicators, and has good clarity of language and instrument structure so that it is

suitable for use in the research data collection process. Then the researcher will test the consistency of the instrument that will be used during the research as shown in the following table 3:

Table 3. Instrument Reliability Test Results

Aspects	Cronbach Alpha Values	Categories
Instruments for Understanding Mathematical Concepts	0,86	Very High
AI Use Perception Instruments	0,91	Very High
Average Reliability	0,89	Very High

Based on Table 3, the results of the reliability test showed that the mathematical concept understanding instrument obtained a *Cronbach Alpha* value of 0,86, while the AI use perception instrument obtained a value of 0,91. The average overall reliability value 0,89 is as large as that belongs to the very high category. This shows that the instrument has a good level of consistency so that it can be used in research.

After calculating the validity and reliability of the instrument. Furthermore, the researcher will conduct tests on students' ability to understand mathematical concepts through *pre-tests* and *post-tests*. This test aims to determine the change in students' abilities after the implementation of AI-assisted learning which can be seen in the following table 4:

Table 4. Distribution of Pre-test and Post-test Scores for Students

Value Interval	Pre-test (f)	Percentage	Post-test (f)	Percentage
50 – 59	6	17,1%	0	0%
60 – 69	13	37,1%	2	5,7%
70 – 79	12	34,3%	10	28,6%
80 – 89	4	11,4%	16	45,7%
90 – 100	0	0%	7	20,0%
Total	35	100%	35	100%

Based on Table 4, it can be seen that before the implementation of *Artificial Intelligence* (AI)-assisted learning, most students were in the value range 60 – 69 with a total of 13 students with a percentage of the same size followed by a value range 70 – 79 of 12 students with the same

34,3% percentage. In addition, there are still 6 students with a high 17,1% percentage of students who get grades in the range 50 – 59 and there are no students who have reached the value range 90 – 100.

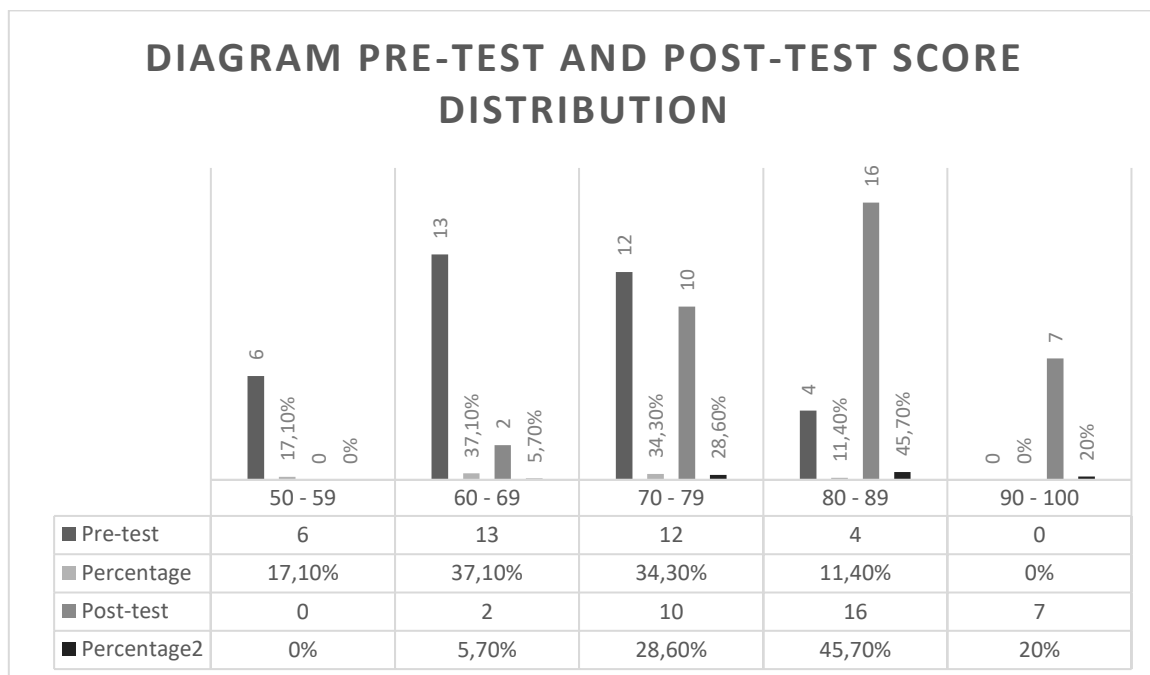


Figure 2. Diagram Pre-test and Post-test Score Distribution

After the implementation of AI-assisted learning, there was a significant change in the distribution of scores, as seen in the students' post-test scores. The majority of students were in the 80-89 range, representing 16 students 45.7%, followed by 10 students in the 70-79 range, representing 28.6%. Furthermore, 7 students, representing 20.0%, reached the 90-100 range. Meanwhile, the number of students in the lower score range decreased significantly, with only 2 students 5.7% remaining in the 60-69 range, and no students in the 50-59 range. The researchers conducted a descriptive analysis of the distribution of pre-test and post-test scores, as shown in Table 5 below:

Table 5. Descriptive Analysis of Pre-test and Post-test Scores

Categories	Pre-test	Post-test
Avarage	67,54	82,63
Standard Deviation	8,72	7,46
Minimum Score	52	68
Maximum Value	81	95

Based on Table 5, the average *pre-test* score of students is 67.54 with a standard deviation of 8.72, while the average *post-test* increases to 82.63 with a standard deviation of 7.46. The decrease in standard deviation from 8.72 to 7.46 also shows that the variation in students' scores after learning becomes smaller. The results showed an increase in the average score of 15.09 or around 22.34%, indicating that the use of AI made a positive contribution to improving students' understanding of mathematics concepts. This indicates that students' abilities tend to be more evenly distributed after the implementation of AI-assisted learning. The findings show that AI not only contributes to improved learning outcomes, but also helps reduce the ability gap between students.

To determine the influence of the implementation of *Artificial Intelligence* (AI) on students' ability to understand mathematical concepts, statistical hypothesis testing was carried out. Before hypothesis testing is carried out, a prerequisite test is first carried out in the form of a data normality test to ensure that the research data is distributed normally. After the assumption of normality was met, the analysis was continued using a *paired sample t-test* to identify differences in student learning outcomes before and after the implementation of AI-assisted learning.

Table 6. *Shapiro-Wilk Normality Test Results*

	<i>Shapiro-Wilk</i>	Sig.	Remarks
Pre-test	0,964	0,212	Normal
Post-test	0,971	0,341	Normal

The results of the normality test showed a significance value of 0.212 for the pre-test and a *post-test* value of 0.341. Because the significance value is greater than 0.05, the data is declared to be normally distributed so that it can be continued using the *paired sample t-test*.

Table 7. Paired Sample t-test results

	t-count	Sig.	Remarks
Pre-test and Post-test	8,72	0,000	H_0 Rejected

The results of the *paired sample t-test* showed a *t-count* value of 8.72 with a significance value of 0.000. Because the significance value is less than 0.05, it can be concluded that there is a significant difference between student learning outcomes before and after the implementation of AI-assisted learning

DISCUSSION

The results of the study show that the implementation of AI has a positive impact on improving students' understanding of mathematical concepts. The increase in average scores 22,34% shows that AI is able to help students understand the material more effectively.

One of the factors influencing the increase is AI's ability to provide direct feedback on student mistakes and provide a more personalized learning experience.

The findings of this study are in line with the research of Chen et al. (2023) who stated that the use of *deep learning-based diagnostic feedback* can help identify patterns of students' errors thereby improving understanding of mathematical concepts. In addition, research by Hwang et al. (2020) shows that AI technology is able to increase student engagement through more interactive and adaptive learning.

Zawacki-Richter et al.'s (2021) research also explains that AI makes a positive contribution to learning personalization because the system can tailor the material to the needs of each learner. In this study, students showed a positive response to the use of AI with an average perception value of 84.8% which is included in the very good category.

Nonetheless, the implementation of AI in mathematics education also faces several challenges. The results of the study show that the problem of academic integrity and dependence on technology is quite a dominant obstacle. This condition is in line with UNESCO (2023) which states that the use of AI in education requires regulation and supervision so as not to cause misuse of technology and reduce students' critical thinking skills.

As such, the use of AI in mathematics learning cannot completely replace the role of educators. AI should be used as a learning support tool that helps increase the effectiveness of the learning process, while educators still have a leading role in developing students' critical thinking skills, creativity, and character

CONCLUSION

Based on the results of the study, it can be concluded that the implementation of *Artificial Intelligence* (AI) in mathematics education has made a positive contribution to improving the competence of prospective mathematics teachers. The results of the analysis showed an increase in students' ability to understand mathematical concepts after the implementation of AI-assisted learning which was shown through an increase in *the average score of the pre-test* in 67,54 by as much as 82,63*the post-test*, with a percentage increase of . In addition, the results of 22,34%*the paired sample t-test* showed a significance value of $0,000 < 0,05$, which indicated a significant influence on student learning outcomes.

The use of AI in mathematics learning provides several opportunities, including increasing learning personalization, accelerating feedback, increasing student involvement in the learning process, and helping to strengthen understanding of mathematical concepts. Students also showed a positive perception of the use of AI in learning with a response rate of as high as the category of excellent.84,8%

However, the implementation of AI also faces several challenges, especially related to academic integrity, digital literacy readiness, and potential dependence on technology. Therefore,

the use of AI in mathematics education cannot completely replace the role of educators, but rather serves as a supporting tool that helps improve the effectiveness and quality of learning.

Further research is suggested to involve a larger sample count, use more complex experimental designs, and examine the influence of AI implementation on other aspects of mathematical abilities such as critical thinking skills, creativity, and mathematical problem-solving

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