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Artificial Intelligence (AI) for Learning Mathematical Content among Elementary Preservice Teachers: Perceptions and Implications for Mathematics Education

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ABSTRACT

This study examined elementary preservice teachers' perceptions of artificial intelligence (AI) as a tool for learning mathematical content. Grounded in the Technology Acceptance Model, the study employed a quantitative design involving preservice teachers at Kwara State University, Nigeria. Data were collected using a questionnaire and analyzed using descriptive statistics, an independent-samples t-test, and analysis of variance. Preservice teachers had positive perceptions of AI for learning mathematics. Perceptions did not differ significantly by gender but differed significantly across years of study. The findings highlight the importance of integrating AI-related pedagogical preparation into mathematics teacher education programs.

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1. INTRODUCTION

Artificial intelligence (AI) is increasingly integrated into education as a tool for supporting teaching, learning, assessment, and instructional decision-making. In teacher education, AI-based applications can assist preservice teachers in developing pedagogical content knowledge, preparing instructional materials, obtaining immediate feedback, and exploring alternative teaching strategies [1-4]. These capabilities are particularly relevant to mathematics education, where learners frequently require visualization, repeated explanation, adaptive feedback, and step-by-step support to understand abstract concepts.

AI-based tools have also expanded opportunities for personalized mathematics learning. Intelligent tutoring systems, generative AI platforms, and mathematics-oriented applications can provide explanations, generate examples, support problem-solving, and allow learners to review mathematical concepts independently [3, 5]. For elementary preservice teachers, these functions are important because they are expected not only to understand mathematical content but also to transform that knowledge into appropriate learning experiences for young students. Their familiarity with AI during teacher preparation may therefore influence both their own learning and their future instructional practices.

The educational value of AI, however, depends partly on how users perceive the technology. Positive perceptions may encourage experimentation, continued use, and integration into classroom activities, whereas uncertainty regarding usefulness, reliability, ethics, or ease of use may reduce adoption. Previous studies have shown that familiarity with educational technology can influence teachers' willingness to use digital tools in instructional settings [6]. At the same time, concerns regarding dependence on technology, privacy, job security, and the changing role of teachers can create anxiety and hesitation toward AI adoption [7].

These issues are particularly relevant in mathematics teacher education. Mathematics learning can involve difficulties related to conceptual understanding, problem solving, confidence, and anxiety. AI has the potential to provide immediate and individualized support when learners encounter such difficulties [5, 8]. Through interactive explanations, guided problem solving, and adaptive responses, AI can function as a supplementary learning resource. Nevertheless, effective use requires preservice teachers to understand both the educational benefits and the limitations of AI.

Research on AI in education has expanded rapidly, but much of the available evidence focuses on higher education students, in-service teachers, secondary education, or general attitudes toward AI [2, 9, 10]. Fewer studies have specifically examined elementary preservice teachers' perceptions of AI as a tool for learning mathematical content [11]. This distinction is important because elementary preservice teachers occupy a dual position: they are learners developing their own mathematical understanding and future teachers who may later integrate AI into elementary mathematics instruction.

Another issue concerns differences among preservice teachers themselves. Gender has frequently been considered in studies of technology acceptance because differences in access, experience, or confidence may influence attitudes toward emerging technologies. However, increasing exposure to digital learning environments may reduce such differences. Year of study may also influence perceptions because students at more advanced stages of teacher education generally have greater exposure to pedagogical courses, instructional technologies, and classroom-related experiences. Examining these characteristics may provide a clearer understanding of how AI readiness develops during teacher preparation.

This study is conceptually supported by the Technology Acceptance Model (TAM), which explains technology adoption primarily through perceived usefulness and perceived ease of use [12, 13]. In the context of this study, perceived usefulness concerns the extent to which preservice teachers consider AI beneficial for learning mathematics, while perceived ease of use relates to their ability to interact with AI tools without excessive difficulty. Constructivist perspectives also support the educational use of AI because learning can occur through exploration, interaction, feedback, reflection, and active knowledge construction [3, 5, 14].

Despite growing interest in AI-supported education, empirical evidence concerning elementary preservice teachers' perceptions of AI specifically for learning mathematical content remains limited. The novelty of this study lies in examining AI from the perspective of future elementary teachers as mathematics learners and in determining whether their perceptions vary according to gender and year of study. Therefore, this study aimed to investigate elementary preservice teachers' perceptions of AI as a tool for learning mathematical content. Specifically, it addressed the following research question: What are elementary preservice teachers' perceptions of AI as a tool for learning mathematical content?

The study also tested two hypotheses:

(i) H01: There is no significant difference in elementary preservice teachers' perceptions of AI as a tool for learning mathematical content based on gender.

(ii) H02: There is no significant difference in elementary preservice teachers' perceptions of AI as a tool for learning mathematical content based on year of study.

2. LITERATURE REVIEW

2.1. AI in Mathematics Education

AI offers several functions that are relevant to mathematics education, including adaptive feedback, guided problem solving, visualization, automated explanation, and individualized learning support. These functions can help learners engage with mathematical concepts at their own pace while receiving immediate responses to questions or errors [3, 5]. AI-based systems can therefore complement conventional instruction by supporting repeated practice and allowing students to explore different approaches to mathematical problems. Interactive AI tools can also contribute to learner engagement. Applications that generate explanations, provide worked examples, or respond to mathematical questions may make learning more accessible and encourage independent exploration [1, 3]. Similar technologies have been associated with improved conceptual understanding, confidence, and engagement in mathematics learning [5, 14]. For learners requiring additional support, AI can provide scaffolding and adaptive assistance that would otherwise be difficult to deliver continuously in conventional classroom settings. The potential of AI extends to inclusive education. Adaptive systems can provide different forms of instructional support according to learners' needs and may increase access to mathematical learning for students requiring specialized assistance [15, 16]. Intelligent tutoring systems can similarly imitate selected functions of human tutoring by delivering immediate feedback and structured guidance [5, 17]. However, AI should be treated as a complementary instructional resource rather than a replacement for teachers because human judgment, interaction, empathy, and contextual understanding remain essential components of education.

2.2. AI and Preservice Teacher Education

Preservice teachers' experiences with AI can influence their future classroom practices. Exposure to AI during teacher education can help them understand how emerging technologies may support lesson planning, content exploration, differentiated instruction, assessment, and reflective practice [1, 3]. Familiarity with these applications may also strengthen technological competence and encourage future teachers to evaluate AI critically rather than use it only as an automated source of answers. Positive perceptions are particularly important for sustained adoption. Preservice teachers who perceive AI as useful and manageable may be more willing to incorporate it into their professional learning and subsequent instructional practices [6]. Structured exposure, institutional support, and appropriate training can strengthen confidence in educational technologies [9]. Conversely, insufficient preparation may result in uncertainty about how AI should be integrated pedagogically. Several concerns may limit adoption. These include data privacy, algorithmic bias, academic integrity, overreliance on technology, reduced teacher agency, and fears regarding the future role of educators [7, 10, 18]. Preservice teachers are still developing professional identities, making explicit preparation for responsible AI use particularly important. Teacher education programs should therefore address both practical use and ethical decision-making. Experience may also shape perceptions. Learners who have greater exposure to AI-supported activities may better understand the advantages and limitations of these tools [2]. Consequently, year of study may be related to perceptions because students in advanced levels may have accumulated more academic, pedagogical, and technological experience. Investigating such differences can provide evidence for determining when and how AI-related competencies should be introduced within teacher education programs.

2.3. Theoretical Perspective

The Technology Acceptance Model provides the principal theoretical basis for explaining preservice teachers' perceptions of AI [12, 13]. The model proposes that perceived usefulness and perceived ease of use influence an individual's willingness to accept technology. Within mathematics teacher education, AI is more likely to be accepted when preservice teachers believe that it improves mathematical learning and can be used without excessive effort. A constructivist perspective further explains how AI may support mathematical learning. Interactive systems can encourage learners to ask questions, investigate solutions, receive feedback, and revise their understanding through active engagement [3, 5, 14]. AI can therefore provide scaffolding during mathematical problem solving while supporting increased learner independence. Together, technology acceptance and constructivist perspectives provide an appropriate framework for examining how elementary preservice teachers perceive AI as a learning tool.

3. METHOD

3.1. Research Design and Participants

The study employed a quantitative research design to examine elementary preservice teachers' perceptions of AI as a tool for learning mathematical content. The study was conducted in the Department of Early Childhood and Primary Education at Kwara State University, Nigeria. Participants were purposively selected based on their exposure to AI and their specialization in elementary mathematics. A total of 74 pre-service teachers participated in the study, consisting of 32 males and 42 females. Participants represented different years of study. Participants were informed about the purpose of the study, the absence of anticipated risk, the anonymity of their responses, and their rights as research participants. Data collection was conducted after regular class sessions over a period of two weeks.

3.2. Instrument and Data Collection

Data were collected using the Questionnaire on Elementary Preservice Teachers' Perception of AI as a Tool for Learning Mathematics (QEPTPAILM). The questionnaire was adapted from an existing instrument developed to assess perceptions of AI in mathematics-related learning [19].

The initial instrument contained 18 Likert-scale items ranging from Strongly Agree to Strongly Disagree. Content validation was conducted by three professors specializing respectively in elementary education, mathematics education, and educational technology at the College of Education, Kwara State University.

Reliability was examined through preliminary administration to 24 preservice teachers. Six items were removed because they reduced internal consistency. After removal, the reliability analysis produced a Cronbach's alpha of 0.79, indicating acceptable internal consistency. The resulting questionnaire was subsequently administered to the 74 participants included in the main study.

3.3. Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to determine the overall perception of AI for learning mathematical content. An independent-samples t-test was used to examine differences according to gender, while one-way analysis of variance (ANOVA) was used to determine whether perceptions differed across years of study.

Before inferential analysis, assumptions of normality and homogeneity of variance were examined. The Shapiro-Wilk test produced $p = 0.517$, while Levene's test produced $p = 0.836$, indicating that the assumptions required for the subsequent analyses were satisfied. Statistical significance was evaluated at the 0.05 level, and full p-values were reported where applicable.

4. RESULTS AND DISCUSSION

The results of these analyses are presented in **Tables 1-4** in the Results and Discussion section. **Table 1** summarizes participants' perceptions of AI for mathematics learning, **Table 2** presents the gender comparison, **Table 3** reports the ANOVA based on year of study, and **Table 4** presents the corresponding mean scores across the four years of study.

4.1. Elementary Preservice Teachers' Perceptions of AI for Learning Mathematical Content

The perception of elementary preservice teachers toward AI as a tool for learning mathematical content was examined using 12 questionnaire statements. The results are presented in **Table 1**. The weighted mean was 4.72, indicating that elementary preservice teachers had a positive perception of AI as a tool for learning mathematical content. All statements obtained relatively high mean scores, demonstrating consistent positive responses toward the use of AI in mathematics learning.

Table 1. Elementary preservice teachers' perceptions of AI as a tool for learning mathematical content.

S/N	STATEMENT	MEAN
1	I find AI a useful tool for improving my mathematical skills.	4.72
2	With the help of AI, I can verify or check the answers to my questions about mathematics.	4.64
3	I can learn about mathematics topics I do not know using AI.	4.68
4	AI teaches me like a teacher or an expert in mathematics lessons.	4.96
5	Using AI, I can improve my mathematical problem-solving skills.	4.50
6	The use of AI will be of benefit to me in my future career.	5.00
7	AI is useful for studying for mathematics exams or doing homework.	4.68
8	I easily ask AI questions about mathematics.	4.70
9	I think it is fun to use AI while studying mathematics.	4.95
10	AI is like a close friend when I study mathematics.	4.43
11	Asking questions about mathematics to AI is exciting.	4.78
12	Asking questions about mathematics to AI interests me.	4.54
	Weighted Mean	4.72

The highest mean score was obtained for the statement that AI would be beneficial to participants' future careers (M = 5.00). This result indicates that the participants recognized the relevance of AI not only for their current mathematical learning but also for their future professional responsibilities. The statement that AI teaches like a teacher or mathematics expert also received a high mean score (M = 4.96), while the statement describing AI use as fun during mathematics learning obtained M = 4.95. These findings indicate that participants regarded AI as both educationally useful and engaging.

The remaining items also showed consistently positive responses, indicating that participants viewed AI as useful for mathematical skill development, problem solving, independent learning, and academic support.

The lowest mean score in **Table 1** was found for the statement that AI was like a close friend while studying mathematics (M = 4.43). However, this value remained within the positive response range used in the study. Thus, even the lowest-rated statement reflected generally favorable attitudes toward AI-supported mathematics learning.

The positive overall perception may be related to preservice teachers' familiarity with technology-enhanced learning environments. Technology is increasingly used to simplify difficult mathematical ideas, provide explanations, and assist independent learning. Previous research has similarly shown that learners demonstrate enthusiasm toward technology in mathematics because it can make learning more interesting and improve understanding [20]. AI-supported tools have also been reported to assist learners through clear explanations, visualization, and guided mathematical problem solving [5].

The findings are also consistent with previous evidence showing that AI applications may improve engagement and understanding in mathematics education [16]. AI tools can offer explanations, immediate responses, and opportunities for repeated learning, which may help learners interact with mathematical content more independently. The strongly positive perceptions reported in **Table 1** therefore support the growing educational role of AI in mathematics learning.

For preservice teachers, these perceptions are particularly relevant because they are preparing to become classroom teachers. Positive experiences with AI during teacher education may help them understand its potential educational functions. At the same time, their responses show that they already associate AI with mathematical learning, problem solving, examination preparation, and future professional practice.

4.2. Perceptions of AI Based on Gender

The first hypothesis examined whether elementary preservice teachers' perceptions of AI as a tool for learning mathematical content differed according to gender. The independent-samples t-test results are presented in **Table 2**. Male participants obtained a mean score of 4.73, while female participants obtained a mean score of 4.70. The difference between the groups was small. The analysis produced t = 0.623, with df = 72 and p = 0.535. Because the significance value was greater than 0.05, the result indicated no statistically significant difference in perceptions based on gender.

Table 2. Difference in elementary preservice teachers' perceptions of AI as a tool for learning mathematical content based on gender.

GENDER	n	MEAN	SD	t	df	Sig.	REMARK
Male	32	4.73	0.16	0.623	72	0.535	Not significant
Female	42	4.70	0.14				

Therefore, H01 was not rejected. Male and female elementary preservice teachers showed similarly positive perceptions of AI as a tool for learning mathematical content. The result indicates that gender did not significantly influence how participants evaluated AI for mathematics learning within this sample.

This finding may be related to comparable access to digital devices and online learning platforms. The increasing normalization of technology-supported learning may have provided male and female students with similar opportunities to interact with educational technologies. The extensive use of digital learning during the COVID-19 period may also have increased exposure to technology among students regardless of gender.

The finding is consistent with previous research reporting no significant gender difference in students' overall perceptions of AI [10]. Similar findings have also been reported in technology-supported mathematics learning, where enthusiasm toward educational technology did not substantially differ according to gender [20]. These results suggest that positive attitudes toward AI-supported learning can be shared across male and female preservice teachers when both groups are exposed to similar technological environments.

The lack of a significant gender difference is also important for teacher education because it suggests that both male and female preservice teachers may respond positively to the integration of AI into mathematics-related learning activities. In this study, the slightly higher male mean did not represent a statistically meaningful difference. Accordingly, the principal finding from **Table 2** is the similarity, rather than the difference, between the two groups.

4.3. Perceptions of AI Based on Year of Study

The second hypothesis examined whether elementary preservice teachers' perceptions of AI differed according to year of study. The results of the analysis of variance are presented in **Table 3**. The analysis yielded $F(3,70) = 9.293$ with $p < 0.001$. Because the significance value was below 0.05, there was a statistically significant difference in elementary preservice teachers' perceptions of AI based on year of study. Consequently, H02 was rejected.

Table 3. Difference in elementary preservice teachers' perceptions of AI as a tool for learning mathematical content based on year of study.

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	Sig.
Between Groups	0.475	3	0.158	9.293	<0.001
Within Groups	1.193	70	0.017		
Total	1.668	73			

The mean perception scores across the four years of study are presented in **Table 4**. Fourth-year students recorded the highest mean score (M = 4.85). Third-year students obtained M = 4.69, followed by second-year students with M = 4.67, while first-year students recorded the lowest mean score (M = 4.64). All four groups nevertheless showed positive perceptions of AI.

Table 4. Mean scores of elementary preservice teachers' perceptions of AI as a tool for learning mathematical content based on year of study.

S/N	YEAR OF STUDY	MEAN
1	First year	4.64
2	Second year	4.67
3	Third year	4.69
4	Fourth year	4.85

Fourth-year students had the highest mean perception score, while first-year students had the lowest. The original study interpreted this pattern as an indication that students at higher academic levels may have developed a greater appreciation of AI for mathematics learning. Students who have spent more time in their academic programs may have greater familiarity with educational technologies and more experience in using digital resources for learning.

In contrast, first-year students are at an earlier stage of their academic programs and may have had less exposure to educational applications of AI. This difference in academic experience was identified in the original study as a possible explanation for the variation in perception across years of study.

Previous research has similarly reported that awareness and experience can influence how educators perceive AI-supported tools [16]. Greater familiarity with AI may allow users to recognize its potential benefits for engagement and understanding. Exposure and hands-on experience have also been associated with more informed and positive perceptions of AI in educational contexts [2]. Continuous interaction with AI-supported learning tools may further help learners understand how such technologies can support mathematical reasoning and problem-solving [5].

Taken together, **Tables 3 and 4** show that year of study was associated with differences in perception within the sample. While all groups reported positive perceptions, fourth-year students had the highest mean score and first-year students had the lowest. These findings support the importance of exposure and experience in shaping perceptions of AI during teacher education.

The findings presented in **Tables 1-4** demonstrate that elementary preservice teachers had strongly positive perceptions of AI as a tool for learning mathematical content. Gender did not produce a statistically significant difference, whereas year of study showed a significant difference. The findings indicate that perceptions varied by year of study but not by gender within the participants examined in this study.

These results support the recommendation in the original study that teacher education institutions provide pre-service teachers with opportunities to learn about the pedagogical use of AI for mathematics. Such preparation should also include guidance regarding plagiarism, overreliance on AI, and data privacy. These issues are necessary to ensure that positive perceptions of AI are accompanied by responsible use in mathematics education.

5. CONCLUSION

Elementary preservice teachers generally perceived AI positively as a tool for learning mathematical content. Gender did not significantly influence their perceptions, whereas year of study showed a significant difference, with fourth-year students recording the highest mean score. These findings indicate that academic exposure and experience may shape how preservice teachers view AI-supported mathematics learning. Teacher education programs should therefore provide structured opportunities for preservice teachers to develop pedagogical competence in using AI for mathematics instruction. Such preparation should also address responsible use, including plagiarism, overreliance on AI, and data privacy in future professional educational settings.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper is free from plagiarism.

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