| RESEARCH ARTICLE

The Influence of Artificial Intelligence Technology on the Mathematical Literacy Competence of Secondary Education Students

Nur Komalasari [1] , Yopi Romafilani [2], Martini [3], Surya Amami Pramuditya [4] Ramnita Saini Sharda [5]

[1] *Master of Mathematics Education, Postgraduate School, Universitas Swadaya Gunung Jati, Indonesia.*

[2] *Master of Mathematics Education, Postgraduate School, Universitas Swadaya Gunung Jati, Indonesia*

[3] *Master of Mathematics Education, Postgraduate School, Universitas Swadaya Gunung Jati, Indonesia*

[4] *Master of Mathematics Education, Postgraduate School, Universitas Swadaya Gunung Jati, Indonesia*

[5]*Hans Raj Mahila Maha Vidyalaya College, Jalandhar, India*

Corresponding Author: Surya Amami Pramuditya, **E-mail**: amamisurya@ugj.ac.id

| ABSTRACT

The primary issue of this research is the inadequate mathematical literacy among secondary school students and the potential use of artificial intelligence (AI) technology to enhance these competencies. This research aims to examine the influence of AI integration on mathematics education and the function of educators in the instructional process. The research methodology used is a hybrid approach, integrating qualitative and quantitative research, emphasizing observation and interviews conducted at three high schools in West Java. Data was gathered from 108 pupils using a random sample that included a variety of student characteristics. The findings indicate that the use of AI in mathematics education significantly enhances students' mathematical literacy, including problem-solving and reasoning abilities. The involvement of educators in crafting dynamic and relevant learning experiences is essential for the effective integration of this technology. This research concludes that instructors must use a technology-driven and participatory methodology to get optimum outcomes in mathematics literacy. Further investigation is necessary to examine the enduring effects of AI on mathematical instruction.

| KEYWORDS

Mathematical Literacy; Artificial Intelligence (AI); Mathematics Learning; problem solving; mathematical reasoning

| ARTICLE DOI:

I. INTRODUCTION

Mathematical literacy is a crucial element of secondary education, enabling students to use mathematical knowledge in practical contexts and enhance their problem-solving abilities. [1]. Quality mathematics teaching is essential to support students' mathematical literacy skills, which involves planning, implementing, and evaluating learning outcomes [2]. Teachers play an important role in fostering students' mathematical literacy and should continue to develop their mathematical literacy skills [3]. Integrating various educational theories and concepts can effectively improve the practical application of students' mathematical knowledge [4].

Engaging students in mathematical modeling activities have been shown to improve their mathematical literacy skills [5] significantly. Teachers need a deep understanding of mathematical literacy to integrate it into their teaching practice [6] effectively Strategies such as deep learning can improve students' math literacy and core literacy, contributing to a more holistic educational experience [7].

Mathematical literacy is not only essential for academic success but also for practical applications in everyday life and the workforce, emphasizing problem-solving, reasoning, and real-world relevance [8]. Enhancing fundamental literacy via mathematical reasoning and instruction may augment students' capacity to address real-world challenges in accordance with the changing educational environment and pedagogical approaches. [9]. The correlation between mathematics literacy and financial literacy underscores the need to include both competencies in educational curricula to provide students with vital life skills. [10].

The incorporation of Artificial Intelligence (AI) in education has emerged as a prominent emphasis in recent years, with AI significantly altering conventional teaching and learning methodologies. [11]. AI in education is considered the driving force behind today's technological revolution, with education being the main application scenario and development direction for AI [12]. This shift towards AI in education is seen as important in helping educators meet their goals and improve the learning process [13].

Since the 1970s, Artificial Intelligence in Education (AIEd) has developed, impacting the integration of technology in pedagogy to enhance the learning experience and elevate student performance. [14]. Artificial intelligence has the capability to provide customized educational experiences adapted to the specific requirements, learning speed, and priorities of each learner. [15]. Additionally, AI technology has shown significant potential in education, introducing new possibilities to traditional teaching models as time goes on [16].

The application of AI in education goes beyond traditional teaching methods to include areas such as ideological and political education. AI technology has been used to improve ideological and moral education by creating multi-dimensional learning scenarios and improving educational effectiveness through deep learning capabilities [17], [18]. Additionally, AI technology can provide intelligent decision support for education managers, helping to predict student learning progress and recommend teacher training to facilitate more accurate decision-making [19].

As AI increasingly influences the educational environment, it is essential for educators and learners to get pertinent training to adeptly use AI technology and attain significant enhancements in teaching and learning. [20]. The use of AI in second-language instruction offers novel options for learners, emphasizing AI's revolutionary potential across many educational settings. [21]. The influence of AI on pedagogy and scholarship in higher education indicates a technological transformation that will redefine the framework of global higher education. [22].

To comprehend the influence of AI on the mathematical literacy abilities of secondary school students, it is essential to examine the effects of AI technology on educational practices. The use of AI in education may enhance students' mathematical literacy via many methodologies.

Research by [5] emphasizes that mathematical modeling exercises grounded on STEM methodologies substantially enhance the mathematical literacy competencies of high school pupils. This indicates that integrating AI-driven mathematical modeling exercises might enhance students' mathematical literacy abilities. Furthermore, [23] highlighted the significance of logical intelligence in enhancing mathematical literacy for the resolution of quotidian mathematical challenges. This indicates that AI technology that fosters logical reasoning might enhance pupils' mathematics literacy.

Further, [24] discusses the impact of mathematical reasoning and critical thinking skills on mathematical literacy skills, emphasizing the need for further research in this area. This suggests that AI tools that focus on developing students' reasoning and critical thinking skills have the potential to improve their math literacy skills. In addition, [25] shows that virtual mathematics kits (VMK) using digital media have a significant impact in supporting students' mathematical literacy skills. This shows that AI-powered educational tools like VMK can play an important role in improving students' math literacy.

Mathematical literacy encompasses a wide range of skills and competencies that allow individuals to engage effectively with mathematical concepts in a variety of contexts. It involves understanding and applying mathematical knowledge in real-life situations, making informed decisions using mathematical reasoning, and communicating mathematical ideas effectively.

According to [26], academic literacy in mathematics consists of three integrated components: mathematical proficiency, mathematical practice, and mathematical discourse. These components emphasize not only mastering mathematical content but also applying mathematical reasoning and communication skills. [27] highlights that mathematical literacy involves formulating mathematical problems, solving them, and interpreting solutions in real-world contexts, aligning with the PISA framework's definition of mathematical literacy as the ability to apply mathematical concepts to practical situations.

The results of the study [28] emphasized that the goal of mathematical literacy is to ensure that students understand the relevance of mathematics in the world, make informed decisions using mathematical knowledge, and apply mathematical reasoning in various aspects of their lives. [29] describes mathematical literacy as the ability to utilize mathematical knowledge, propose and solve mathematical problems in different situations, and have the motivation to do so, emphasizing the practical application of mathematical skills in a variety of contexts.

The application of Artificial Intelligence (AI) in education involves integrating AI technology into the education system to enhance the learning experience, personalize teaching, improve educational outcomes, and support teaching practices. The app includes a

variety of tools and approaches designed to assist students, teachers, and educational institutions in various aspects of the learning process.

One of the key aspects of AI applications in education is the development of personalized learning experiences. AI-powered adaptive learning platforms can analyze students' learning patterns, preferences, and performance data to provide learning paths tailored to individual needs [20]. For example, AI algorithms can recommend specific learning resources, adjust task difficulty levels, and offer real-time feedback to support student learning progress [30].

Additionally, the application of AI in education extends to the creation of interactive and engaging learning content. Virtual reality simulations, augmented reality tools, and gamification learning platforms leverage AI technology to immerse students in a dynamic and interactive learning environment [31]. These tools increase student engagement, promote active learning, and facilitate hands-on experiences in a variety of educational subjects, including STEM fields [32].

AI also plays an important role in supporting teachers and educational institutions. Teacher-facing AI tools provide educators with data-driven insights, automated grading systems, and personalized teaching recommendations to improve instructional practice and student outcomes [33]. Additionally, system-facing AI applications help educational institutions streamline administrative tasks, optimize resource allocation, and improve decision-making processes [33].

In addition, the application of AI in education contributes to the development of intelligent tutoring systems, chatbots for student support, and virtual assistants for administrative tasks [34]. These AI tools improve the efficiency of the educational process, provide hands-on assistance to students, and offer personalized guidance to facilitate learning.

Based on the references provided, recent research has explored the use of Artificial Intelligence (AI) in mathematics education, highlighting various applications and benefits in educational settings. The study focuses on the use of AI technology to improve mathematical thinking skills, improve learning outcomes, and support students and educators in the teaching and learning process.

For example, [35] discusses how utilizing AI Chatbots in mathematics education can improve the mathematical thinking skills of high school students, which aims to support the learning process and encourage the development of critical thinking skills among students. [36] explored the possible use of AI in mathematics education, aiming to provide a comprehensive understanding of the role and impact of AI in mathematics teaching and learning. The study explores trends, AI methods, technology applications, and opportunities for teachers and students to utilize AI in mathematics education.

[37] conducted a systematic literature review on artificial intelligence in mathematics education, emphasizing the positive impact of AI-assisted teaching on basic mathematics education. This study highlights the effectiveness of AI technology in improving the learning process and teaching practices in mathematics education. [38] discusses the implementation of AI in STEM-based creative learning, emphasizing how AI technology can improve student performance, support educators in designing learning experiences, and improve learning strategies in mathematics and related fields.

Overall, the study underscores the potential of AI applications in mathematics education to improve learning outcomes, improve critical thinking skills, and provide personalized learning experiences for students. By effectively utilizing AI technology, educators can create innovative and engaging learning environments that meet the diverse needs of learners in mathematics education.

II. METHODOLOGY

Qualitative methodologies have been widely used in mathematics education research, focusing on teaching experiments, realistic mathematics education (RME) approaches, and analysis of mathematical communication difficulties [1], [2], [3], [4]. This study offers valuable insights into the effectiveness of qualitative approaches in improving mathematics learning outcomes.

This study was taken from 3 classes in 3 different schools in cities and districts in West Java province with a total of 108 students. The sample of this study was taken with only 5 participants at random by looking at the diverse character of students. This study was focused on three high schools in cities and districts in West Java Province, with a sample of 2 students in each school as observation subjects and research data sources. Data was also collected through interviews with students who were used as research samples in each school to ensure the accuracy of the information. The researcher took samples from the three high schools because the researcher worked in the education unit.

The validity of the data was tested by the triangulation method, which is verifying the data in the field after the research is completed. Data collection techniques include observation and interviews, while triangulation tests are used to ensure the validity and reliability of qualitative research findings. By using multiple methods or data sources, researchers can cross-verify their results, thereby increasing the confidence of conclusions [39]

III. RESULTS AND DISCUSSION

This study uses a structured assessment rubric, which includes several important aspects such as the accuracy of analysis, understanding the context, the ability to analyze team performance, and the ability to present solutions or scenarios.

TABLE 1.
Student Answer Analysis Table

No	Assessment Criteria	Persentase	Grade Point Average	Information
1	**Calculation Accuracy**	*40%*	*6.2*	*Most students give quite precise calculations.*
2	**Ability to Analyze Scenarios**	*30%*	*2.0*	*The analysis of scenario implications for PERSIJA's position varies.*
3	**Suitability to Questions**	*20%*	*1.4*	*The student's answers are not in accordance with the questions asked.*
4	**Ability to Present Solutions or Recommendations**	*10%*	*0.4*	*Few students are able to present solutions or recommendations.*

Source: 2024 Research Results

Table 1. provides an overview of the results of the analysis and student performance in the research conducted.

Accuracy of calculations (40%): Students are generally able to provide fairly accurate calculations, but some are less accurate. This shows that most students show a good understanding of how to calculate points in the context of a match, with some students able to provide accurate calculations. However, there are some students who have difficulty in doing the correct calculations, which shows the need to strengthen their understanding of the basic concept of point calculation in competitions. Therefore, it is recommended that more exercises and case examples related to the calculation of points in competitions be provided, as well as question and answer sessions to clarify concepts that students may not have understood well. Calculation accuracy is one of the important aspects of team performance analysis. Although most students are able to provide quite good calculations, there is still room for improvement, especially for students who are having difficulties. Strengthening in understanding basic concepts and more intensive practice is expected to improve the accuracy of calculations in the future.

Ability to analyze scenarios (30%): There is variation in students' ability to analyze the implications of a given scenario. This shows that some students show a good understanding of how match scenarios can affect a team's position in the rankings. They were able to associate the outcome of the match with the possible outcome. However, many students are not able to provide in-depth or relevant analysis. This suggests that they may not fully understand the relationship between match results and ranking positions. Therefore, it is advisable to provide more practice in analyzing match scenarios, including group discussions and case studies. Using match simulations can also help students understand the implications of various match outcomes. The ability to analyze scenarios is an important aspect of understanding the dynamics of competition. Although some students showed good ability, many still needed to improve their understanding of how match scenarios could affect the team's position. With a more interactive and case-based learning approach, it is hoped that students' analytical skills can improve significantly.

Relevance to Questions (20%): Many students do not give answers that match the questions. This shows that most of the students who get high scores have a good ability to understand and answer questions according to the given context. They are able to relate the answer to relevant information. However, some students showed difficulty in understanding the question as a whole, resulting in their answers being inconsistent. This may be due to a lack of understanding of the context or ambiguity in the question. Therefore, it is recommended that further training in understanding and analyzing questions must be provided. Holding discussion sessions on how to interpret questions and providing examples of good answers can help students improve the suitability of their answers.

Ability to Present Solutions or Recommendations (10%): Few students are able to present relevant solutions or recommendations. This shows that students who score high show a good understanding of the situation the team is facing and are able to provide practical and applicable recommendations. They can relate their analysis to relevant solutions. Yet many students are unable to provide adequate solutions, demonstrating a lack of understanding of how to develop effective recommendations. This may be due to a lack of practice in critical and analytical thinking. Therefore, it is recommended that training sessions be held that focus on developing the ability to present solutions and recommendations. Using case studies and simulations can help students learn how to formulate the right solution based on the analysis that has been carried out. The ability to present solutions or recommendations is an important aspect of student analysis assessment. Although some students show good abilities, many still need to improve their skills in formulating relevant and applicable recommendations. With a learning approach that is more

focused on developing critical thinking and analytical skills, it is hoped that student's ability to present solutions can improve significantly.

Based on the interpretation of the results of questionnaire data, interviews, and mathematical literacy tests, the following picture was obtained:

1). Accuracy of Calculations: The results showed that most of the students were able to provide precise and accurate calculations to determine the maximum number of points that could be obtained by the team, such as PERSIJA. This reflects a good understanding of the basic mathematical concepts required for team performance analysis. However, there are also students who provide inaccurate or inaccurate calculations, indicating a gap in their understanding of more complex mathematical concepts. 2). Ability to analyze scenarios: In the analysis of the implications of the given scenario, students show variations in analytical skills. Some students are able to analyze well, while others provide only limited analysis. This suggests that even if students have a solid foundation in calculations, they may need more practice in applying their mathematical knowledge to real-world situations. 3). Conformity with Questions: Most students give answers that match the questions asked. However, there are also students who give answers that are not appropriate or relevant. This indicates the need for reinforcement in reading and comprehension skills, which are an important part of mathematical literacy. 4). Ability to Present Solutions or Recommendations: Students' ability to present solutions or recommendations related to strategies that can be used by the team shows that even though they have analytical skills, there is still room for improvement in terms of creativity and critical thinking. Students who are unable to present relevant solutions demonstrate the need for further development in these skills.

Increased Access to Learning Resources: AI can provide wider access to a wide range of learning resources, including interactive tutorials, learning apps, and online platforms that offer practice questions. With these resources in place, students can learn in a more flexible and self-paced way, which can improve their understanding of mathematical concepts.

Learning Personalization: AI technology allows for the personalization of the learning experience. AI-based learning systems can analyze students' strengths and weaknesses in mathematical literacy and adjust learning materials according to individual needs. This can help students who may have difficulty understanding certain concepts, thus improving their overall abilities.

Increased Student Engagement: The use of AI in math learning can increase student engagement. With the gamification and interactivity features offered by AI-based apps, students are more motivated to learn and practice. This higher engagement can contribute to improved learning outcomes and understanding of mathematical concepts.

Real-Time Data Analysis and Feedback: AI can provide in-depth data analysis of students' progress in math literacy. With real-time feedback, students can immediately identify areas that need improvement and get recommendations for additional exercises. This helps students to overcome difficulties faster and improve their understanding.

Problem-Solving Skills Development: AI can assist students in developing better problem-solving skills. By providing a variety of complex mathematical scenarios and challenges, students are encouraged to think critically and creatively in finding solutions. This is especially important in mathematical literacy, where the ability to apply concepts in real-life situations is indispensable.

Limitations and Challenges: While AI offers many benefits, there are also challenges to be aware of. Excessive reliance on technology can reduce students' ability to think independently and solve problems without help. Additionally, not all students have equal access to technology, which can create gaps in learning.

In the discussion of the main findings of the research on the impact of Artificial Intelligence (AI) technology on the mathematical literacy ability of secondary education students, several important points can be raised and associated with the previous literature. This study found that the integration of AI technology in mathematics learning significantly improved students' mathematical literacy skills. Students who engage in learning activities that utilize AI show improvements in problem-solving abilities, mathematical reasoning, and practical applications of mathematical concepts in everyday life. This is in line with research by [5], which shows that STEM-based mathematical modeling activities can significantly improve students' mathematical literacy skills.

Mathematical Literacy and AI: These findings support a view [28] that emphasizes the importance of understanding the relevance of mathematics in everyday life and the application of mathematical reasoning. By using AI, students not only learn mathematical theory but also how to apply it in real contexts, which is the core of mathematical literacy.

The Role of Teachers and Teaching Methodologies: This research is also in line with the view [6], which states that teachers need to have a deep understanding of mathematical literacy in order to integrate it into their teaching practice. In the presence of AI, teachers can design more interactive and relevant learning experiences, which in turn can improve student engagement and their learning outcomes.

Problem-Solving Skills: [23] emphasizes the importance of logical intelligence in improving mathematical literacy skills. The findings of this study suggest that AI can facilitate the development of students' logical intelligence through simulation and modeling, allowing students to practice solving everyday math problems in a more effective way.

Implications for Education Policy: These findings provide important implications for education policy, especially in terms of the integration of technology into the curriculum. In line with the recommendations of [2], it is important for educational institutions to consider the use of AI as an aid in mathematics teaching to improve students' overall mathematical literacy.

Based on the results of interviews with students regarding the impact of Artificial Intelligence (AI) technology on the mathematical literacy ability of secondary education students, the following are the conclusions: 1). The majority of students reported that the use of AI in mathematics learning helped them understand difficult concepts better. AI provides detailed explanations and clear problem-solving steps so students can learn independently. 2). Students appreciate the flexibility offered by AI technology, which allows them to learn anytime and anywhere. AI also provides access to a variety of additional learning resources that help enrich their understanding. 3). AI provides fast and instant feedback, helping students correct their mistakes immediately. This increases students' confidence in working on math problems. 4) While AI is helpful, some students realize the potential to become overly reliant on this technology. They acknowledged the importance of continuing to try to solve problems independently to truly understand the material. 5). The use of AI makes mathematics learning more interactive and fun, thereby increasing students' motivation and interest in learning.

The findings of the research on the impact of Artificial Intelligence (AI) technology on the mathematical literacy ability of secondary education students have significant implications for both teaching practices and educational policies. Here are some key points that can be raised: 1). The findings show that the use of AI in math learning can improve student engagement and learning outcomes. With AI, teachers can design more interactive and adaptive learning experiences, allowing students to learn at their own pace and learning style. For example, AI can provide real-time feedback and exercise recommendations tailored to students' individual needs. This encourages a more personalized approach to learning, which can increase students' motivation and understanding of math material. 2). AI can provide a variety of complex mathematical scenarios and challenges, which encourages students to think critically and creatively in finding solutions. This is especially important in mathematical literacy, where the ability to apply concepts in real situations is indispensable. Therefore, teachers need to integrate AI-based mathematical modeling activities in their curriculum to help students develop better problem-solving skills. 3). These findings also highlight the importance of relevant training for teachers in using AI technology effectively. Teachers must be equipped with the necessary knowledge and skills to integrate AI into their teaching. Education policies should include training programs that focus on the use of AI technology in education so that teachers can utilize these tools to improve students' mathematical literacy. 4). Education policies need to support the integration of AI technology in the educational curriculum. This includes the provision of adequate resources, equal access to technology, and the development of the necessary infrastructure to support the use of AI in learning. With supportive policies, schools can create a learning environment that is more innovative and responsive to student needs. 5). While AI offers many benefits, challenges such as the technology access gap among students need to be addressed. Education policies must ensure that all students, regardless of their economic background, have equal access to the technology and educational resources necessary to utilize AI in learning. This is important to prevent gaps in mathematical literacy among students.

In this study, there are several limitations that need to be considered regarding the methodology and samples used. These limitations can affect the generalization of research results and the interpretation of findings. Here are some points that explain these limitations: 1). This research uses qualitative and quantitative approaches, which, although they provide comprehensive insights, also have limitations. Qualitative approaches can be influenced by the subjectivity of researchers in interpreting data, while quantitative approaches may not fully capture the nuances of students' experiences in using AI technology. The combination of these two approaches can yield valuable data, but it can also pose challenges in terms of the validity and reliability of results. 2). The research sample consisted of 108 students taken from three high schools in West Java Province. The relatively small sample size and limited to a specific geographic location can limit the ability to generalize findings to a broader population. In addition, the selection of a sample that includes only three schools may not reflect the diversity of student characteristics across regions or countries, so the results of the study may not be universally applicable. 3). The data collection methods used, such as interviews and observations, can be affected by respondent bias. Students may provide expected answers or not be completely honest in answering questions, especially if they feel pressured to give positive answers about the use of AI. Additionally, time and resource limitations can affect the depth and quality of the data collected. 4). This study may not be able to control all variables that can affect students' mathematical literacy, such as parents' educational background, student motivation, and other environmental factors. These variables can contribute to student learning outcomes and can influence the interpretation of AI's impact on mathematical literacy. 5). The time available for this study may not be enough to observe long-term changes in students' mathematical literacy as a result of the use of AI. Longer longitudinal research may be needed to gain a better understanding of the long-term impact of AI technology in mathematics education.

IV. CONCLUSION

This article highlights the importance of mathematical literacy in secondary education and how Artificial Intelligence (AI) technology can contribute significantly to the improvement of those skills. Based on the research conducted, it was found that the integration of AI in mathematics learning not only improves the understanding of basic concepts but also helps students develop essential critical thinking and problem-solving skills in real-life contexts. The results show that AI-based mathematical modeling activities, as well as the use of technological tools that support data analysis and real-time feedback, can accelerate the learning process and improve students' understanding of mathematical materials. While there are challenges, such as reliance on technology and access gaps, the benefits offered by AI in math education are promising. Overall, this article emphasizes that in order to achieve optimal results in math literacy, it is important for educators to adopt a more interactive and technology-based approach. By utilizing AI effectively, it is hoped that students will be better prepared to face future academic and professional challenges. Math literacy is a fundamental aspect of secondary education, equipping students with the skills needed to overcome real-world challenges, make informed decisions, and achieve academic and professional success. The integration of AI technology in education, such as mathematical modeling activities, logical intelligence development, critical thinking skill improvement, and virtual math kits, can positively affect the mathematical literacy skills of secondary education students. By utilizing AI tools that focus on these aspects, educators can create engaging learning experiences that improve students' math literacy abilities.

Overall, the results of the questionnaire and the math literacy test showed that students had a good understanding of basic calculations and analysis, but there were still challenges in terms of in-depth analysis, context understanding, and solution presentation. This research highlights the importance of developing more holistic mathematical literacy skills, which include understanding concepts, applying them in real contexts, and critical thinking skills. Efforts to improve these aspects can be made through more interactive and problem-based teaching methods. The development of AI technology in education holds great promise for revolutionizing teaching and learning practices, providing personalized learning experiences, and improving educational outcomes in various educational domains.

The findings of this study show that AI technology has great potential to improve the mathematical literacy of secondary education students. By relating the results of this research to previous literature, we can see that the integration of AI in education is not only relevant but also necessary to prepare students for increasingly complex real-world challenges. Further research is needed to explore more deeply the most effective methods and strategies for utilizing AI for math learning. This study suggests that the integration of AI technology in mathematics education can have a significant positive impact on teaching practices and educational policies. By adopting a more interactive approach, improving teacher training, and supporting policies that facilitate access to technology, we can improve students' math literacy and prepare them for real-world challenges. Further research is needed to explore the most effective implementation strategies in diverse educational contexts. The limitations of the methodology and samples in this study indicate the need for caution in interpreting the results and generalizing the findings. Further research with a broader and more diverse design, as well as more comprehensive data collection methods, is needed to gain a deeper understanding of the impact of AI technology on students' mathematical literacy in various educational contexts.

Based on the findings and limitations identified in this study, here are some suggestions for further studies on the impact of Artificial Intelligence (AI) technology on the mathematical literacy skills of secondary education students: 1). Conduct longitudinal research that observes the development of students' mathematical literacy over a longer period of time. This will provide deeper insights into the long-term impact of the use of AI technology in math learning and how students' skills are evolving over time. 2). Sampling from different geographic locations and school types (e.g., public, private, and schools with different curricula) to get a more comprehensive picture of the impact of AI. Research that involves more students from diverse backgrounds can be helpful in understanding how social and economic factors affect learning outcomes. 3). Using a more integrated mixed method, combining qualitative and quantitative approaches in more depth. For example, surveys can be combined with in-depth interviews and classroom observations to get richer and more diverse data on student experience and the effectiveness of AI in math learning. 4). Investigate contextual factors that can affect the effectiveness of AI in mathematics learning, such as support from teachers, access to technology, and student motivation. This research can help understand how various elements in the learning environment interact with the use of AI technology. 5). Conduct experiments involving AI-based interventions in mathematics teaching to measure their impact directly on students' mathematical literacy skills. The research could include comparisons between classes that use AI and classes that don't. 6). Conduct an international comparative study to explore how the use of AI in mathematics education varies in different countries. This research can provide insights into best practices and challenges faced in integrating AI technology in mathematics learning in different contexts. 7). Investigate more deeply about how AI can assist students in developing problem-solving and critical thinking skills. This research can explore the types of tasks and challenges that are most effective in improving these skills through the use of AI technology.

REFERENCES

[1] L. H. Muhaimin, "Unlocking the Secrets of Students' Mathematical Literacy to Solve Mathematical Problems: A Systematic Literature Review," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 20, no. 4, p. em2428, 2024, doi: 10.29333/ejmste/14404.

[2] F. K. Nisa and E. Arliani, "Junior High School Students' Mathematical Literacy in Terms of Mathematical Self-Efficacy," *J. Elem.*, vol. 9, no. 1, pp. 283–297, 2023, doi: 10.29408/jel.v9i1.7140.

[3] R. Novita, T. Herman, D. Suryadi, D. Dasari, and M. Putra, "How Pre-Service Elementary Teachers Deal With Mathematical Literacy Problems? A Case Study," 2022, doi: 10.2991/assert.k.211229.022.

[4] I. Baranauskienė and L. Tomėnienė, "Creation of the Methodology of the Development of Functional Mathematical Literacy in the 8th Form of Mainstream School," *Soc. Integr. Educ. Proc. Int. Sci. Conf.*, vol. 3, p. 45, 2015, doi: 10.17770/sie2015vol3.375.

[5] A. Yaprak and A. P. Bal, "The Effect of Mathematical Modeling Activities Based on STEM Approach on Mathematics Literacy of Middle School Students," *Int. J. Educ. Stud. Math.*, vol. 9, no. 4, pp. 233–253, 2022, doi: 10.17278/ijesim.1160204.

[6] T. Kabael and A. A. Baran, "An Investigation of Mathematics Teachers' Conceptions of Mathematical Literacy Related to Participation in a Web-Based PISA Course," *Bartın Univ. J. Fac. Educ.*, vol. 12, no. 2, pp. 315–324, 2023, doi: 10.14686/buefad.1053557.

[7] W. Jian, "Research on Teaching Strategies of Deep Learning in High School Mathematics from the Perspective of Core Literary," *Int. J. New Dev. Educ.*, vol. 5, no. 7, 2023, doi: 10.25236/IJNDE.2023.050717.

[8] K. C. Roohr, E. A. Graf, and O. L. Liu, "Assessing Quantitative Literacy in Higher Education: An Overview of Existing Research and Assessments With Recommendations for Next-Generation Assessment," *Ets Res. Rep. Ser.*, vol. 2014, no. 2, pp. 1–26, 2014, doi: 10.1002/ets2.12024.

[9] J. Shen, "Research on higher vocational mathematics teaching based on core literacy cultivation," *Adv. Vocat. Tech. Educ.*, vol. 5, no. 12, 2023, doi: 10.23977/avte.2023.051207.

[10] I. G. P. Suharta, I. M. Suarjana, and N. N. Parwati, "The Relationship Between Mathematical Literacy and Gender With Financial Literacy," 2020, doi: 10.32698/tech3233.

[11] S. F. Ahmad, M. K. Rahmat, M. S. Mubarak, M. M. Alam, and S. I. Hyder, "Artificial Intelligence and Its Role in Education," *Sustainability*, vol. 13, no. 22, p. 12902, 2021, doi: 10.3390/su132212902.

[12] Q. Qin and L. Ao, "A New World of Open Space - Reflections and Perspectives of Chinese Scholars on the Digital Transformation of Education and Future Education Research," *Medicon Eng. Themes*, Jul. 2023, doi: 10.55162/MCET.05.153.

[13] X. Zhu, "Research on the Application and Future Trend of Artificial Intelligence in Education and Teaching," *SHS Web Conf.*, vol. 187, p. 4017, 2024, doi: 10.1051/shsconf/202418704017.

[14] E. Dimitriadou and A. Lanitis, "A Critical Evaluation, Challenges, and Future Perspectives of Using Artificial Intelligence and Emerging Technologies in Smart Classrooms," *Smart Learn. Environ.*, vol. 10, no. 1, 2023, doi: 10.1186/s40561-023-00231-3.

[15] Z. Erbaşı, "The Role and Potential of Artificial Intelligence and Gamification in Education: The Example of Vakıf Participation Bank," *Orclever Proc. Res. Dev.*, vol. 3, no. 1, pp. 243–254, 2023, doi: 10.56038/oprd.v3i1.329.

[16] Y. Jie, Y. Shuijin, and D. Yubin, "Intelligent Physical Education: Utilizing Artificial Intelligence to Improve Learning Effectiveness," *Adv. Educ. Technol. Psychol.*, vol. 8, no. 3, 2024, doi: 10.23977/aetp.2024.080323.

[17] Y. Li, "Intelligent Ideological and Political Education: The New Role of Artificial Intelligence," *Lect. Notes Educ. Psychol. Public Media*, vol. 51, no. 1, pp. 75–80, 2024, doi: 10.54254/2753-7048/51/20240943.

[18] L. Zheng, "Integrating Artificial Intelligence Technology Into Ideological and Political Education Innovation By Intelligent Edge Cloud Computing," 2022, doi: 10.21203/rs.3.rs-2221384/v1.

[19] C. Xing, "Research on the Application of Artificial Intelligence Empowered Education Management," *J. Artif. Intell. Pract.*, vol. 6, no. 6, 2023, doi: 10.23977/jaip.2023.060602.

[20] L. Li, "Chinese Higher Education Entering the Age of Artificial Intelligence: Opportunities, Challenges and Prospects," *Int. J. New Dev. Educ.*, vol. 5, no. 17, 2023, doi: 10.25236/IJNDE.2023.051708.

[21] U. Soyombo-erdene, "Research on the Application of Artificial Intelligence in Second Language Teaching," *Int. J. New Dev. Educ.*, vol. 6, no. 4, 2024, doi: 10.25236/IJNDE.2024.060406.

[22] S. Popenici and S. Kerr, "Exploring the Impact of Artificial Intelligence on Teaching and Learning in Higher Education," *Res. Pract. Technol. Enhanc. Learn.*, vol. 12, no. 1, 2017, doi: 10.1186/s41039-017-0062-8.

[23] T. Isnani, "Analysis of Students' Mathematical Literacy Ability in Solving Mathematical Problems in View of Logical Intelligence," *Eduinsights*, vol. 1, no. 2, pp. 41–57, 2023, doi: 10.58557/eduinsights.v1i2.9.

[24] L. D. Haeruman, "The Impact of Mathematical Reasoning and Critical Thinking Skills on Mathematical Literacy Skills," *Kne Soc. Sci.*, 2024, doi: 10.18502/kss.v9i13.15957.

[25] L. N. Pradana, O. H. Sholikhah, S. Maharani, and M. N. Kholid, "Virtual Mathematics Kits (VMK): Connecting Digital Media to Mathematical Literacy," *Int. J. Emerg. Technol. Learn.*, vol. 15, no. 03, p. 234, 2020, doi: 10.3991/ijet.v15i03.11674.

[26] J. Moschkovich, "Academic Literacy in Mathematics for English Learners," *J. Math. Behav.*, vol. 40, pp. 43–62, 2015, doi: 10.1016/j.jmathb.2015.01.005.

[27] T. Y. E. Siswono, A. W. Kohar, S. Hartono, A. H. Rosyidi, and P. Wijayanti, "Teachers' Views and Experiences on Mathematical

Literacy and Context-Based Task," 2018, doi: 10.2991/icst-18.2018.166.
[28] X. Chen *et al.*, "Visualizing Status, Hotspots, and Future Trends in Mathematical Literacy Research via Knowledge Graph," *Sustainability*, vol. 14, no. 21, p. 13842, 2022, doi: 10.3390/su142113842.
[29] F. O. Haara, O. H. Bolstad, and E. S. Jenssen, "Research on Mathematical Literacy in Schools - Aim, Approach and Attention," *Eur. J. Sci. Math. Educ.*, vol. 5, no. 3, pp. 285–313, 2017, doi: 10.30935/scimath/9512.
[30] B. TONBULOĞLU, "An Evaluation of the Use of Artificial Intelligence Applications in Online Education," *J. Educ. Technol. Online Learn.*, vol. 6, no. 4, pp. 866–884, 2023, doi: 10.31681/jetol.1335906.
[31] S. M. Vidalis and R. Subramanian, "Impact of AI Tools on Engineering Education," 2023.
[32] W. Xu and F. Ouyang, "The Application of AI Technologies in STEM Education: A Systematic Review From 2011 to 2021," *Int. J. Stem Educ.*, vol. 9, no. 1, 2022, doi: 10.1186/s40594-022-00377-5.
[33] M. Baidya and A. K. C, "Artificial Intelligence in Education: Understanding Benefits, Limitations, and Prospects for the Future," *Int. J. Multidiscip. Res.*, vol. 6, no. 2, Apr. 2024, doi: 10.36948/ijfmr.2024.v06i02.16699.
[34] N. Simhadri, "Awareness Among Teaching on AI and ML Applications Based on Fuzzy in Education Sector at USA," *Soft Comput.*, 2023, doi: 10.1007/s00500-023-08329-z.
[35] N. V Doc, "Teaching Mathematics With the Assistance of an AI Chatbot to Enhance Mathematical Thinking Skills for High School Students," *Int. J. Curr. Sci. Res. Rev.*, vol. 06, no. 12, 2023, doi: 10.47191/ijcsrr/v6-i12-102.
[36] T. Stefanova, "Possibilities for Using AI in Mathematics Education," *Mem*, vol. 53, pp. 117–125, 2024, doi: 10.55630/mem.2024.53.117-125.
[37] R. Hidayat, M. Z. b. Mohamed, N. N. b. Suhaizi, N. b. M. Sabri, M. K. H. bin Mahmud, and S. N. b. Baharuddin, "Artificial Intelligence in Mathematics Education: A Systematic Literature Review," *Int. Electron. J. Math. Educ.*, vol. 17, no. 3, p. em0694, 2022, doi: 10.29333/iejme/12132.
[38] J. M. Sari and E. Purwanta, "The Implementation of Artificial Intelligence in STEM-Based Creative Learning in the Society 5.0 Era," *Tadris J. Kegur. Dan Ilmu Tarb.*, vol. 6, no. 2, pp. 433–440, 2021, doi: 10.24042/tadris.v6i2.10135.
[39] S. Donkoh, "Application of triangulation in qualitative research," *J. Appl. Biotechnol. Bioeng.*, vol. 10, no. 1, pp. 6–9, 2023, doi: 10.15406/jabb.2023.10.00319.