LUMAT
International Journal on Math, Science and Technology Education

Research article

The use of AI-powered math platforms in mathematics learning

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Abstract: Artificial Intelligence-powered technologies are prevalent today, especially in education. Numerous studies have shown an increasing number of students utilizing AI-powered math platforms (AI-PMPs) as supplementary tools for mathematics learning. However, there is limited information on how these platforms specifically benefit pre-service mathematics education teachers at a public higher education institution. To address the population, knowledge, and theory gap, this study aims to evaluate AI-PMPs and students' experiences using them. By employing a convergent parallel mixed-methods approach, the researchers will explore the relationship between the frequency of AI-PMP usage and the students' mathematics performance using a correlational quantitative design, and assess the students' sentiments about AI-PMPs through a descriptive qualitative design. Proportional stratified random sampling was used to select 92 respondents for the quantitative phase, while purposive sampling identified 19 participants for the qualitative phase. Data was gathered through survey questionnaires and one-on-one interviews. The findings revealed that the frequency of AI-PMP usage did not significantly affect students' mathematics performance, highlighting various purposes, impacts, and challenges associated with these platforms. The study found that while AI-PMPs have an inconsistent effect on mathematics performance, they can serve as useful supplementary tools for enhancing learning. Therefore, it is recommended that students not overly rely on and put limits on using AI-PMPs. The study output was a user guide for the commonly used AI-PMPs.

Keywords: artificial intelligence, AI-powered math platforms, mathematics learning, mathematics performance, technology in mathematics

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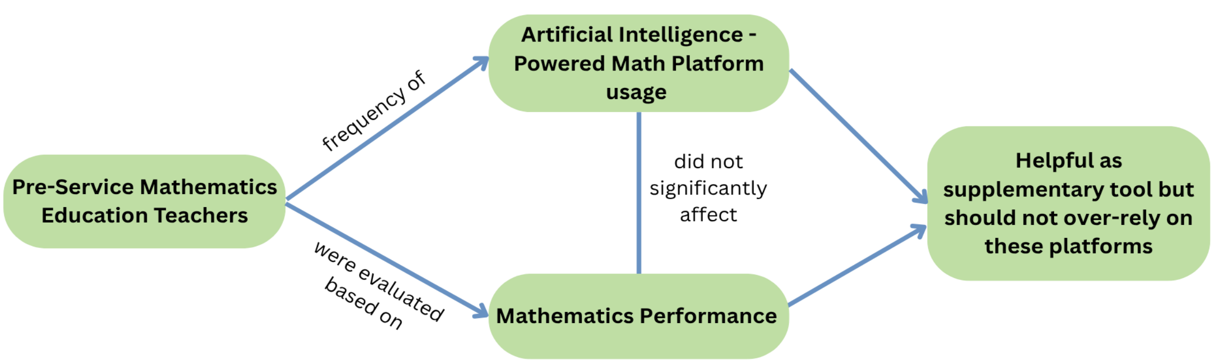


Received 2 July 2025 / Accepted 26 April 2026 / Published 20 August 2026
Published by the University of Helsinki, Finland and LUMA Centre Finland.

1 Introduction

Artificial Intelligence (AI) replicates human cognitive abilities, such as thinking, learning, and executing tasks that typically require human intelligence (Tegmark, 2017). AI-PMPs address today's most urgent educational challenges, enhance teaching and learning methods, and advance the pursuit of SDG 4, ensuring quality education for all (UNESCO, 2022). These platforms shaped education by ushering in an era of personalized and accessible learning.

As a core subject in education, mathematics plays a crucial role in developing students' analytical thinking and problem-solving skills. However, it is often difficult due to its abstract nature and complexity (Blikstein, 2018; Yildirim, 2020). In African nations, academic performance in mathematics is generally low, which affects university choices (International Mathematics Union, 2023; Schappacher, 2022). Similarly, in the U.S., 12th-grade students often lack mathematical competency, impacting their college readiness (Bannister et al., 2014; Galabo et al., 2018). The Philippines also faces significant challenges in math education, ranking 79th globally in terms of education quality (Capuno et al., 2019). Filipino students performed poorly in the TIMSS 2019 and PISA 2018 assessments. In the 2022 PISA assessment, the Philippines ranked 76th out of 81 countries in math proficiency (OECD, 2019; Balancio, 2023).

With the rise of challenges in teaching and learning math, tools like Photomath, developed by Damir Sabol in 2014, have emerged to assist students by providing instant solutions and step-by-step explanations. These AI-PMPs offer tailored exercises that enhance self-analysis, math-solving skills, and critical thinking, leading to improved academic performance and understanding (Gulliford & Miller, 2015; Johnson et al., 2016; Obina et al., 2022). A study at Notre Dame of Midsayap College in the Philippines found that math apps had a positive impact on grades and fostered continuous improvement. However, the effectiveness of these platforms depends on factors such as the complexity of mathematical problems and the personal and technical challenges in online learning environments (Zhang et al., 2015; Bringula et al., 2021). As the Fourth Industrial Revolution emphasizes the interaction between humans and AI, understanding the influence of AI on students' learning is crucial, though potential drawbacks must also be considered (Martin, 2017; Kenas, 2021).

Despite growing evidence on the usefulness of AI-powered mathematics platforms (Chen et al, 2025), most existing studies have focused on short-term achievement gains (Melo, 2024), student perceptions (Kanvaria & Srivastava, 2025), or general student populations, often treating AI tools as supplementary aids rather than as influences on future teaching practices. Moreover, findings on the relationship between AI-assisted learning and mathematical performance remain inconsistent, with some studies reporting positive effects (Chen et al., 2025; Dabingaya, 2025) and others indicating limited or no measurable impact (Sangoniyi et al., 2025), particularly in complex problem-solving contexts.

This study aimed to address several gaps in existing research. It targeted the population gap by focusing on pre-service mathematics education teachers in a public higher institution in the Philippines, who were previously underrepresented. It sought to bridge the knowledge gap by exploring how students' use of AI-PMPs relates to their math performance. Focusing on pre-service mathematics education teachers is crucial because they are future agents of change in mathematics education. Their early experiences with AI-PMPs not only influence their own academic performance but also shape their future pedagogical practices. According to the TPACK framework (Mishra & Koehler, 2006), effective teaching requires the integration of technological, pedagogical, and content knowledge, which pre-service teachers begin to develop during their training. From a constructivist perspective, AI-PMPs serve as scaffolds that help them internalize mathematical concepts. At the same time, from a sociocultural standpoint, their use of these tools equips them to mediate later student learning through appropriate technological integration. Additionally, it aimed to address the theoretical gap by providing evidence on the impact of these platforms on student learning. Furthermore, the study employs mixed methods and seeks to answer the following questions:

- What is the student's profile in terms of mathematics performance, commonly used AI-PMPs, and frequency of using AI-PMPs?
- What are the respondents' assessments of using AI-PMPs, in terms of accessibility, ease of use, accuracy, and privacy?
- Is there a significant relationship between the students' frequency of using AI-PMPs and their mathematics performance?
- What are the advantages and challenges of using AI-powered math Platforms?
- How does the use of AI-PMPs affect students' mathematics performance?
- How do the qualitative and quantitative data converge?

H_0: There is no significant relationship between the students' frequency of using AI-PMPs and their mathematics performance.

1.1 Theoretical Background

This study is grounded in Siemens and Downes' (2005) Connectivism Learning Theory and Rogers' Diffusion of Innovations (DOI) Theory, as cited by Shrivastava (2018) and Halton (2023).

Connectivism emphasizes learning through interconnected networks facilitated by technology. It highlights the role of digital platforms, such as social media, blogs, and videos, in promoting reflection, decision-making, and the sharing of information (George & Downes, 2005; Shrivastava, 2018). It views learning as occurring across networks of connections involving digital tools, fostering adaptable, technology-driven education (Kurt, 2023).

The DOI Theory explains how innovations are adopted over time, based on factors such as compatibility, trialability, complexity, observability, and relative advantage (Rogers, 1962). Compatibility and trialability influence trust and control, while complexity and observability affect ease of use and accessibility. Relative advantage highlights how innovations outperform traditional methods (Almaiah et al., 2022).

These theories highlighted the baseline framework that guided the researchers in examining the assessment of using AI-PMPs and the relationship between students' frequency of using AI-PMPs and their mathematics performance.

1.2 Literature review

The emergence of AI technologies has transformed education by reshaping learning experiences and teaching practices, particularly in mathematics. Research on artificial intelligence in education (AIED) gained momentum in the 1980s, with a strong focus on mathematics education (McCalla, 2023). In mathematics platforms, AI enhances pedagogy by enabling personalized learning, providing immediate feedback, supporting algorithmic problem-solving, and strengthening conceptual understanding (Williams, 2020; Abar et al., 2024). As a result, AI-based mathematics platforms such as ChatGPT, Symbolab, and Photomath are increasingly adopted in education, offering students faster and more accessible solutions (Vintere et al., 2024), as well as clear visualizations and structured problem-solving support when facing difficulties with conceptual understanding and formal mathematical procedures (Soesanto et al., 2022; Narboux & Durand-Guerrier, 2022; Efendi et al., 2024). These learning challenges have contributed to the growing reliance on AI-powered mathematics platforms (AI-PMPs) in mathematics learning.

Before the advent of AI, mathematics learning relied primarily on manual calculations, textbooks, and teacher assistance (Zhang et al., 2022; Vintere et al., 2024). Historically, the visualization of numerical concepts began with simple tallying methods and evolved into complex mathematical principles and problem-solving practices (Genckaya & Tan-Sisman, 2021). Learning tools later progressed from basic calculators to Computer Algebra Systems (CAS), which efficiently solved complex mathematical problems such as expanding algebraic expressions, solving equations, and finding anti-derivatives (Zotos, 2024). The integration of AI further advanced these tools into AI-PMPs. According to Zhang et al. (2022), AI-PMPs provide an effective mathematical foundation for technological advancements and societal growth by enhancing computing power, improving mathematical practices, and enabling the automatic correction of mathematical problems. These platforms enable students to explore mathematical concepts more quickly and easily, complete tasks, understand solution steps, address learning gaps, and verify answers independently, thereby promoting self-directed learning (Williams, 2020; De Oliveira Andrade et al., 2023; Vintere et al., 2024). Consistent with this, Xu (2024) noted that AI-PMPs improve students' comprehension, academic performance, computational thinking, and problem-solving abilities.

AI-PMPs are highly accessible and adaptable across multiple platforms, including tablets, computer software, online applications, and smartphones, allowing users to select media that best suit their learning needs (Yalalov, 2023; Parmar, 2023). Examples of widely used systems include Symbolab, Microsoft Math Solver, Desmos, GeoGebra, and Photomath (Yalalov, 2023). Research suggests that the use of these platforms can influence students' academic performance. Dabingaya (2022) found that increased interaction frequency and improved post-assessment scores demonstrate how tailored learning paths offered by AI-powered adaptive platforms enhance student engagement and learning outcomes. Similarly, studies indicate that integrating AI-PMPs such as Mathway, GeoGebra, and Photomath into mathematics education can improve students' academic performance (Obina et al., 2022; Abar et al., 2024). According to Obina et al. (2022), math applications support academic performance by addressing mathematical difficulties, supplementing instruction, and encouraging learning. Reports from UNICEF (2021) on Filipino students during the pandemic reinforce this trend, indicating that usage frequency may also influence academic performance.

Despite their broad accessibility and potential benefits, AI-PMPs present several challenges. Issues related to accuracy, internet connectivity, and language barriers may limit their effectiveness (Taani & Alabidi, 2024). Variations in platform accuracy, particularly in specific mathematical topics where performance is lower, can affect user satisfaction and learning outcomes (Zong & Krishnamachari, 2023). In addition, differences in users' educational backgrounds and technological familiarity may hinder effective platform use (Msomi & Bansilal, 2018). These authors further note that inadequate internet access and limited device availability can negatively affect the use of AI-based learning tools. Addressing these challenges through continued development and research is essential to help students navigate AI-PMPs effectively and overcome difficulties in mathematics learning.

Several studies have reported a relationship between students' academic performance and the frequency of AI-PMP use, regardless of the strength of the correlation. The use of AI in mathematics learning has been found to influence students' behavior and academic performance (Seo et al., 2021). Guided by existing theories and the reviewed literature, the present study examines the use of AI-PMPs in mathematics learning through both quantitative and qualitative approaches to gain a deeper understanding of their role and impact in contemporary educational contexts.

2 Methodology

2.1 Research design

This study employed a convergent parallel design, a mixed-methods approach, in which researchers simultaneously worked on both quantitative and qualitative aspects. It considered both methods equally, analyzed each component separately, and interpreted the combined results (Mikhail, 2023). In the context of this study, a correlational research design was used in the quantitative approach to investigate the relationship between the frequency of using AI-PMPs and their mathematics performance. The qualitative approach used a descriptive design to describe the students' assessment of using AI-PMPs.

2.2 Sample and data collection

The respondents of this study are pre-service mathematics education teachers from first to fourth year at a public higher education institution in the Philippines during the 2023–2024 academic year. These students were chosen because their program involves tackling complex math problems, making them likely users of AI-PMPs. This made them ideal participants to explore how frequently they use these tools and how it impacts their mathematics performance.

In the quantitative phase, the researchers employed proportional stratified random sampling to select the respondents for this study. The researchers utilized Slovin’s formula to determine the sample size of the respondents. Out of 119 students, 92 were chosen as respondents with a 5% margin of error. Most respondents are between 18 and 20 years old, accounting for 60.87% of the total population. 38.04% are aged 21-23, and 1.09% are older than 27. Out of 92 respondents, 15 students, or 16.30%, were male, and 76, or 82.61%, were female respondents. The remaining respondents, comprising only 1.09% or one person, were categorized as “others.”

The study utilized a printed survey questionnaire as the data collection method. The questionnaire was a combination of adapted questionnaires from the studies of Almaiah et al. (2021), Obina et al. (2022), Tantri et al. (2024), Kay (2022), Yilmaz et al. (2023), and researcher-made questions. The respondents received the printed survey questionnaires face-to-face, so the study has precise data with which to work. It underwent validity and reliability tests to ensure its appropriateness for the study. Specifically, a panel of experts in Mathematics validated the questionnaire's content and language. This resulted in an overall validity index and S-CVI of 1.00 for each variable, confirming the items' relevance and clarity. It was pilot-tested on 30 fourth-year BSIE (Bachelor of Science in Industrial Engineering) students. Cronbach's Alpha is a measure used to assess the reliability or internal consistency of a set of scale or test items (Cronbach, 1951). The reliability test outcomes were as follows: Accessibility (0.71), Ease of Use (0.92), Accuracy (0.86), Privacy (0.95), and overall Cronbach’s alpha for the entire instrument (0.93). Thus, the research survey questionnaire was reliable and internally consistent.

In the qualitative phase, the researchers employed purposive sampling and established inclusion criteria to select participants from the 92 respondents for data collection. To be eligible for the qualitative phase, participants must have participated as respondents in the quantitative phase of the study and demonstrated a high or low assessment of the use of AI-PMP based on their responses in the quantitative phase. As soon as data saturation was reached, the sampling ended, and nineteen (19) students were interviewed in total.

The researchers employed a validated interview guide with researcher-created open-ended questions to elicit participants' responses on the advantages and challenges of using AI-PMP and how using AI-PMP affects students' mathematics performance. The one-on-one interview involves asking participants open-ended questions and following up with probing questions further to explore their responses and the topic of interest.

The content validation for the interview guide produced an overall validity index of 1.00 with an S-CVI of 1.00 for each variable in both the degree of relevance and clarity. Content experts also validated these questions, and they were pilot-tested on four fourth-year industrial engineering students, allowing the researchers to refine the interview flow and inform the development of the final interview questions. These results suggest that all questions were relevant to the study and that the language was clear.

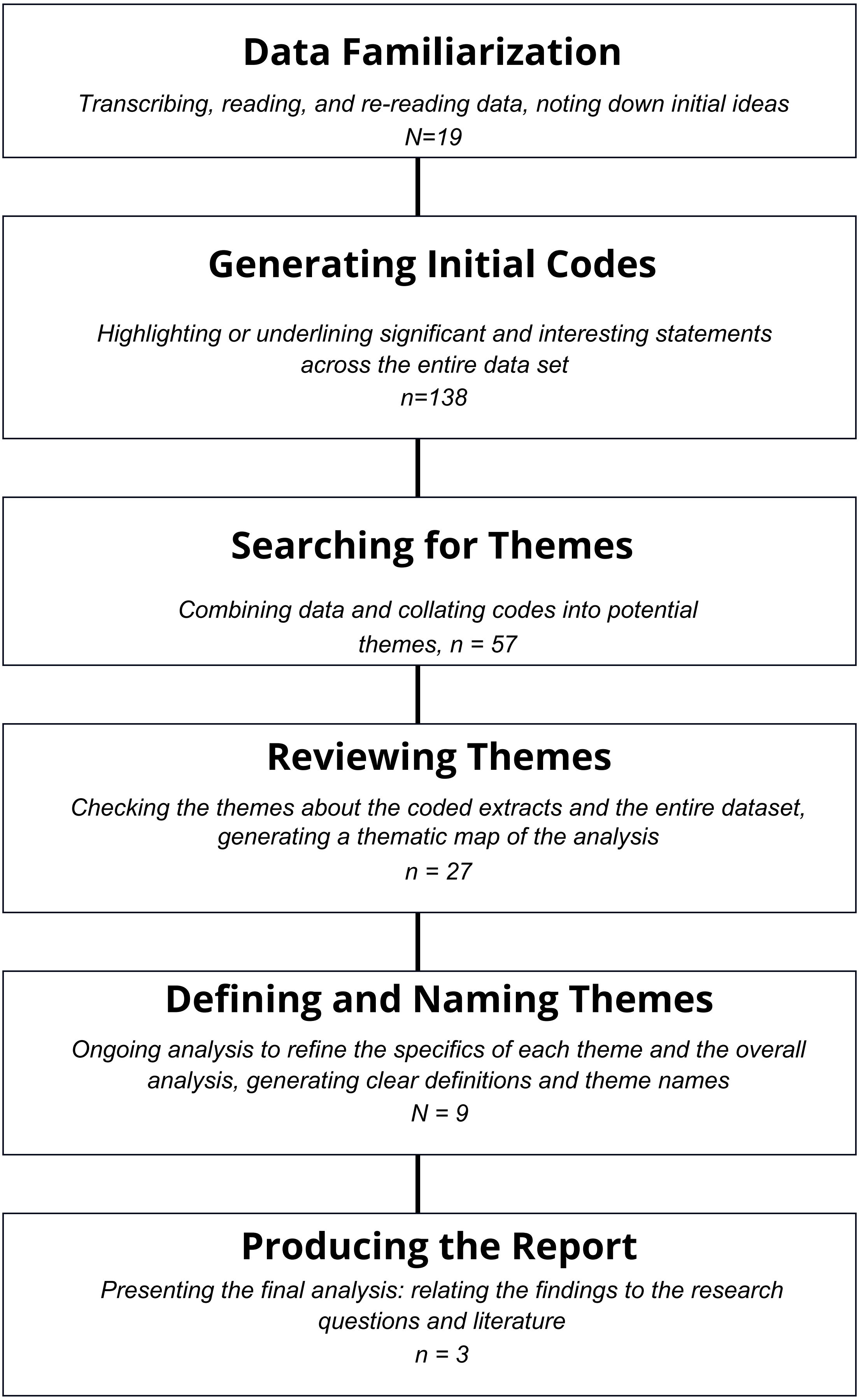
2.3 Analyzing of data

In the quantitative phase, as soon as all the respondents responded to the survey questionnaire, the researchers consolidated all the responses and tallied them using a frequency count and simple percentage for the profile of the respondents, a weighted mean and standard deviation to determine the dispersion of the responses in terms of frequency of use and assessment of the use of AI-PMPs, and a Pearson-r correlation coefficient for the significant relationship between the students' frequency of use of AI-PMPs and their mathematics performance. All data were sorted, tabulated, and analyzed using SPSS and Excel software.

In the qualitative phase, this study utilized the six-step thematic analysis method by Braun and Clarke (2013). The steps involved in the analysis were: (1) data familiarization, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. This method guided the researchers in identifying recurring themes, patterns, and emerging perceptions and insights from the qualitative data.

The researchers began by transcribing the interview responses, verifying the accuracy of the transcriptions, and familiarizing themselves with the data by reading it multiple times while recording initial thoughts. Initial codes were generated by highlighting significant phrases grouped for further analysis. The researchers then searched for themes by identifying patterns within the codes and gathering relevant data. After reviewing and refining these themes, they created a visual representation of their relationships and defined them through ongoing analysis to ensure clear and meaningful definitions. The researchers then integrated the qualitative data, which provided insights into he challenges and benefits of AI-PMPs and their impact on students' math performance, with the quantitative data, which offered statistical insights into usage frequency, accessibility, accuracy, ease of use, and privacy. This integration aimed to comprehensively understand the research questions by leveraging both qualitative and quantitative approaches.

Figure 1. Summary of Braun and Clarke Thematic Analysis for qualitative data



3 Results

Based on the mixed method approach data, the following findings were revealed:

3.1 Quantitative phase

3.1.1 Assessment of the use of AI-powered math platforms

3.1.1.1 Accessibility

Regarding respondents' accessibility on AI-PMPs, it was identified that the total weighted mean for accessibility is 2.80, falling within the range of 2.51 - 3.25, which corresponds to the categorical response and implies high accessibility. It has the highest rate in the statement, indicating that AI-PMPs are responsive and work well on various devices. At the same time, it has the lowest mean on the statement stating that it can be accessed even offline.

Table 1. Accessibility of AI-PMPs

Statements **The AI-PMPs:**	**Mean**	**s**	**Categorical Description**
1. have simple features.	3.14	0.54	H
2. offer multiple ways to access content, such as voice commands and keyboard input.	2.95	0.74	H
3. can choose specific subjects/courses to access.	3.09	0.56	H
4. can be accessed even offline.	1.62	0.75	VL
5. are responsive and work well on different devices (e.g., tablets, smartphones, computers).	3.23	0.59	H
Overall	2.80	0.88	H

Legend: s - Standard Deviation

Weighted Mean Interval	**Categorical Response**	**Description**
3.26 - 4.00	Strongly Agree	Very High Accessibility (VH)
2.51 - 3.25	Agree	High Accessibility (H)
1.76 - 2.50	Disagree	Low Accessibility (L)
1.00 - 1.75	Strongly Disagree	Very Low Accessibility (VL)

3.1.1.2 Ease of use

In terms of ease of use, the total weighted mean is 3.17, falling within the range of 2.51 - 3.25, which corresponds to the categorical response agreement and implies high usability. The highest statement rated implies that AI-PMPs have a user-friendly interface. While the statement, *"The AI-PMPs are easy to use by different types of learners"*, received the lowest.

Table 2. Ease of Use of AI-PMPs

Statements The AI-PMPs:	Mean	s	Categorical Description
1.have a user-friendly interface.	3.24	0.52	H
2. are easy to navigate.	3.18	0.55	H
3. offer clear instructions.	3.12	0.53	H
4. provide a step-by-step process.	3.23	0.66	H
5. are easy to use by different types of learners.	3.10	0.66	H
6. have a fast response time.	3.16	0.59	H
Overall	3.17	0.59	H

3.1.1.3 Accuracy

In the accuracy, the total weighted mean is 2.88, falling within the range of 2.51 - 3.25, which corresponds to the categorical response agreement and implies high accuracy. The statements with the highest mean stated *"The AI-PMPs provide reliable information,"* and *"The AI-PMPs provide clear and well-structured solutions to math problems."* While *"The AI-PMPs offers explanations that are compatible with the teacher's discussion,"* received the lowest.

Table 3. Accuracy of AI-PMPs

Statements The AI-PMPs:	Mean	s	Categorical Description
can identify and address learning gaps in math.	2.90	0.49	H
provide reliable information.	3.01	0.60	H
provide clear and well-structured solutions to math problems.	3.01	0.60	H
provide solutions to math problems similar to what is found in the textbook.	2.82	0.61	H
offers explanations that are compatible with the teacher's discussion.	2.73	0.59	H
give precise supplementary resources.	2.78	0.62	H
Overall	2.88	0.60	H

Legend: s - Standard Deviation

3.1.1.4 Privacy

Moreover, the total weighted mean for privacy is 2.95, falling within the range of 2.51 - 3.25, which corresponds to the categorical response agree and implies high security. The statement, *"The AI-PMPs inform users of the importance of securing data"*, got the highest weighted mean. On the other hand, the statement, *“The AI-PMPs ensure the security of collected information,”* received the lowest weighted mean.

Table 4. Privacy of AI-PMPs

Statements The AI-PMPs:	**Mean**	**s**	**Categorical Description**
ensure the security of collected information.	2.91	0.60	H
take adequate measures to protect the user’s privacy.	2.93	0.55	H
address concerns about the misuse of data.	2.93	0.53	H
inform users of the importance of securing data.	2.99	0.63	H
take measures to prevent unauthorized access to personal data.	2.98	0.53	H
Overall	2.95	0.57	H

Legend: s - Standard Deviation

Weighted Mean Interval	**Categorical Response**	**Description**
3.26 - 4.00	Strongly Agree	Very High Privacy (VH)
2.51 - 3.25	Agree	High Privacy(H)
1.76 - 2.50	Disagree	Low Privacy (L)
1.00 - 1.75	Strongly Disagree	Very Low Privacy (VL)

3.1.1.5 Overall assessment

Overall, the weighted mean for using AI-PMPs is 2.93. This result indicated that the respondents agreed with the statements under each variable. This further denotes that the student’s assessment of using AI-PMPs in Mathematics Learning is high, inferring that it is useful.

Table 5. Overall assessment of the use of AI-PMPs

Indicators	Mean	s	Categorical Description
Accessibility	2.80	0.88	H
Ease of Use	3.17	0.59	H
Accuracy	2.80	0.60	H
Privacy	2.95	0.57	H
Overall	2.93	0.68	H

3.1.2 Significant relationship between the frequency of using AI-powered math platforms and mathematics performance

On the students' frequency of using AI-PMPs in correlation with their mathematical performance. The r-value of 0.164 was determined, indicating a very low positive correlation between the frequency of using AI-PMPs and their mathematics performance. In addition, there is no significant correlation between students' frequency of using AI-PMPs and mathematics performance, as evidenced by the computed p-value exceeding the predetermined significance level (0.05).

Table 6. Relationship between the respondents' frequency of using ai-powered math platforms and mathematics performance n=19

Variable	Mathematics Performance	r -value	p-value	Decision	Interpretation
Frequency of Using AI-PMPs	*College and Advanced Algebra Grade*	*0.164*	*0.119*	*Failed to reject Ho*	*Not Significant*

3.2 Qualitative phase

Based on the one-on-one interview data, the participants revealed that they used AI-PMPs for various purposes, including tools for intended learning support, enhancement, and immediate feedback. Additionally, they have been able to identify the impacts that it may have on them along their learning process. The positive impacts include increasing their mathematics performance and enhancing their understanding. The only negative they implied was that it could increase their dependency on AI. Furthermore, the participants identified challenges of using AI-PMPs, including lack of accuracy, lack of offline accessibility, and lack of lasting effects.

3.2.1 Purpose of using AI-PMPs

The availability of AI-PMPs caused widespread interest and adoption among students. Several students received assistance from these resources in their mathematics learning. It has advantageous effects on students as it was designed to answer and solve numerous mathematical problems (Obina, 2022). Alongside that, the participants realized a variety of reasons behind the utilization or purposes of using AI-PMPs, and the following subthemes emerged:

Table 7. Purpose of Using AI-PMPs

Sub-themes	Description	Sample Statements
Tool for Intended Learning Support	The participants use certain AI-PMPs because of the perceived gaps in teaching practices and the lack of learning support students received due to their unique learning styles. These shortcomings often result in learners lacking sufficient skills and comprehension. Thus, students turn to AI-PMPs for additional support and guidance, seeking aid for intended learning support.	*"During that time, since there were no face-to-face interactions and no teacher presence, it led us to self- learning...what I did was I utilized an application called Photomath."- P1* *"I cannot understand the lesson coming from the teacher, so I use Mathway to help me understand the lesson easier. And I can answer my activities or assignments easier in a way that I can understand them better than the teacher's discussion."-P7* *"There were times when I could not fully grasp the lessons discussed with our professor. I used AI- powered tools to solve equations."- P14.*
Tool for Learning Enhancement	The use of these platforms is driven by their ability to offer a wide range of personalized assistance, particularly for students. Acting as aids for learning improvement, these platforms empower students to enhance their understanding of mathematical concepts and engage in more in-depth exploration of their courses or subjects.	*"You can study in advance using AI-math tools, like for example Photomath "- P17* *"I specifically use, recently, Symbolab and ChatGPT in dealing with Calculus problems and Mathematical proving, respectively. Moreover, these tools indeed supplement my mathematical learning as I was able to grasp mathematical procedures on how to integrate complex integrals and how to lay down my proofs comprehensively."- P7.* *"In learning complex topics in Math, AI-powered tools are particularly helpful in improving my understanding of the topic, getting some strategies for solving a specific problem, and checking, especially during the online class."- P9.*
Tool for Immediate Feedback	The participants used AI-PMPs because they were convenient and could provide immediate responses. With AI-PMPs, the students had a convenient tool for swiftly obtaining answers and explanations by just inputting prompts.	*"Immediate feedback provided by the platform allowed me to identify and correct mistakes quickly, leading to improved performance on assignments and exams."- P15. "While with AI, you just take a picture, and the answer will be given."-P17* *"The instant feedback provided by these platforms helps me identify and correct mistakes quickly, leading to more efficient learning." – P19*

3.2.2 Impact of Using AI-PMPs

Math learning platforms have changed the landscape of mathematics education, providing unparalleled accessibility, customization, and engagement. These platforms use technology to give students access to resources targeted to their needs and learning styles. According to Chubb et al. (2021), using AI has several positive and negative consequences. Aligned with that, the participants identified the impacts of using AI-PMPs, and the following sub-themes emerged:

Table 8. Impact of using AI-PMPs

Sub-themes	Description	Sample Statements
Increased Mathematics Performance	The participants emphasize the improvements in mathematics performance achieved through the integration of AI-PMPs in their learning process.	*"When AI was introduced, although there were disadvantages, it had a significant impact on my grades. It is not like they skyrocketed, but they did improve."- P3.* *"And in Photomath, it was not recommended by our teacher, but for some reason, it helped us since it is user-friendly, so it helped particularly on my grades."- P11.* *"It would add up to my participation points and also to my grades because since you know how to solve it, during exams, you also know the answer."- P12.*
Enhanced Understanding	This signifies that the participants have deepened their comprehension of mathematical concepts through AI-PMPs.	*"Helping me understand math problems that I did not know because Gauthmath and Photomath gave me a step-by- step solution to a specific problem that I needed." -P5* *"I am not saying it is solely about grades because I only use AI- PMPs sometimes, and then, but for my understanding, for example, if I have confusion, I will have a better grasp."- P12.* *"I can say that there has been improvement since I have also grasped ideas that from the step- by-step that can make me say that it is possible in the way that it can be answered on the approach."-P16*
Increased Dependency on AI	The participants have shown over-reliance on the responses provided by the AI-PMPs. They tend to believe the immediate feedback hinders their personal growth and development, making them complacent in their skills.	*"Immediate feedback provided by the platform allowed me to identify and correct mistakes quickly, leading to improved performance on assignments and exams."- P15. "While with AI, you just take a picture, and the answer will be given."-P17* *"The instant feedback provided by these platforms helps me identify and correct mistakes quickly, leading to more efficient learning." – P19*

3.2.3 Challenge of Using AI-PMPs

The integration of AI-PMPs in education offers various advantages. These platforms could adapt to students' learning styles and pace, providing tailored lessons and exercises for students (Alam, 2023). However, despite these advantages, several challenges are still associated with using AI-PMP. According to Hall et al. (2023), the usability of AI-driven platforms presents several challenges, including system comprehension, feedback quality, error handling, and the cultivation of trust through accuracy and accessibility. The participants infer that there are several challenges that they experienced while engaging in the AI-PMP, which led to the emergence of the following sub-themes:

Table 9. Challenge of using AI-PMPs

Sub-themes	Description	Sample Statements
Lack of Accuracy	The participants encountered challenges in the reliability of the correctness and precision of the answers provided by the AI-PMPs.	*"Al-powered tools help solve complex mathematical equations. However, I try to check if the answers are correct because Al- powered tools are not always reliable." -P9.* *"It can explain, but there were times when it could not arrive at the answer...There are times when it cannot provide the answer accurately, or its answer might differ from what the teacher teaches... the explanations are just limited." - P16.* *"I find that the AI's answer is not right, and its steps are lengthy compared to the teacher's, which is more like direct ... in AI the explanation was so broad" – P17*
Lack of Offline Accessibility	The participants emphasize the accessibility that the AI-PMPs can guarantee. This has been a challenge because not all AI-PMPs can function online and are always free to access.	*"Limited for online use" -P12* *"The Photomath that I used was available offline, but it was not very effective in generating solutions than on online pace" -P16.* *"For online use only" -P17*
Lack of Lasting Effects	The participants encountered no lasting effects from the use of AI-PMPs. Integrating AI-PMPs did not sustainably alter the participants' behaviors, habits, or perceptions.	*"I cannot say that it has a lasting effect on my academic performance because if I use an AI, I will directly copy the answer."-P1.* *"The app helped me finish homework quicker, but it did not make me better at math overall." - P6.* *"It made my grades better, but I am not sure if it helped me understand math more." - P9*

4 Discussion

This study employed a mixed-methods design to examine the use of AI-powered mathematics platforms (AI-PMPs) and their relationship with students' mathematics performance. Integrating quantitative and qualitative findings enabled a more nuanced understanding of how these platforms operate in practice, beyond what could be inferred from a single methodological approach (Nguy et al., 2024; Teddlie & Tashakkori, 2009; Maarouf, 2019). Rather than producing convergent results, the two data strands revealed complementary yet contrasting insights that underscore the complexity of AI-PMP use in mathematics learning.

Quantitative findings showed no significant relationship between the frequency of AI-PMP use and students' mathematics performance. This result suggests that frequent interaction with AI-PMPs alone is insufficient to improve academic outcomes, reinforcing the view that learning gains depend not only on tool usage but also on how these tools are pedagogically integrated. This finding aligns with Bancoro (2024), indicating that AI platforms do not automatically enhance achievement and that other factors, such as prior knowledge, learning strategies, and instructional guidance, likely play a more decisive role. From a theoretical perspective, these challenges support learning theories that emphasize meaningful engagement and cognitive processing rather than mere exposure to digital tools.

In contrast, qualitative findings revealed that students perceive AI-PMPs as valuable supports for learning, particularly for providing immediate feedback, clarifying solution steps, and reinforcing understanding. These perceived benefits are consistent with Obina (2022), who highlighted the role of math applications in facilitating problem-solving and learning processes. The divergence between perceived usefulness and measurable performance suggests that AI-PMPs may enhance learning experiences without necessarily translating into higher grades. This finding highlights a key distinction between affective and cognitive outcomes, suggesting that AI-PMPs may support motivation, confidence, and task completion more effectively than deep conceptual mastery.

The integration of findings related to accessibility, ease of use, and accuracy further illustrates this complexity. Quantitatively, students rated AI-PMPs highly in terms of accessibility and usability, reflecting the convenience of mobile-based learning and the step-by-step guidance provided (Etcuban & Pantinople, 2018; Muttaqin et al., 2023). However, qualitative data revealed critical limitations, particularly the lack of offline access, which poses challenges for students with unstable internet connectivity. This finding refines the quantitative result by showing that "high accessibility" is conditional and uneven, supporting Yalalov and Dey's (2023) argument that platform design does not always align with diverse learner contexts.

Similarly, while quantitative results suggested high accuracy, qualitative accounts revealed concerns about unclear explanations and incompatibility with teachers' instructional approaches. This discrepancy indicates that accuracy in AI-PMPs may be procedural rather than pedagogical; solutions may be correct, but explanations may not align with classroom instruction or promote conceptual understanding. This inconsistency supports Zong and Krishnamachari's (2023) assertion that variability in AI responses can undermine the reliability of learning, particularly when students rely heavily on these tools.

Taken together, the findings suggest that AI-PMPs function best as supplementary learning tools rather than as substitutes for instruction. While students value their convenience and immediate support, over-reliance may limit opportunities for sustained cognitive engagement and deeper understanding. From a pedagogical standpoint, this highlights the importance of guided and balanced AI integration, where teachers scaffold students' use of AI-PMPs to support conceptual learning rather than relying on shortcuts for problem-solving. Theoretically, the results contribute to ongoing discussions in educational technology by demonstrating that the effectiveness of AI tools depends less on frequency of use and more on purposeful integration within learning processes.

5 Conclusions

Pre-service mathematics education teachers in public higher education institutions in the Philippines have limited engagement with AI-powered mathematical platforms (AI-PMPs). Although these platforms are highly beneficial, the study reveals that the frequency of their use does not significantly impact students' mathematics performance. This result suggests that factors beyond AI-PMPs may impact their academic outcomes. Consequently, there is a need for further research into the complex nature of mathematics learning and the various factors affecting students' performance. The students have continued to use AI-PMPs primarily for intended learning support, learning enhancement, and quick responses to prompts. This usage aligns with Connectivism theory, which underscores the significant role of technology in the learning process.

Additionally, AI-PMPs are valued for providing evidence of their effectiveness and reinforcing their continued use as learning aids. This finding is consistent with the Diffusion of Innovation theory, which explains that users adopt new technologies when they see clear evidence of their benefits. Thus, the pre-service mathematics education teacher can be considered part of the "early majority," adopting AI-PMPs due to observed positive outcomes and recommendations. However, the study also highlights that despite the advantages, AI-PMPs present challenges, suggesting that these platforms can be a double-edged sword for students. The study's findings suggest several key recommendations. Training programs for students and educators should be implemented to effectively integrate AI-PMPs into teaching and learning. These could include seminars, conferences, or online courses to help educators understand the features of AI-PMPs and incorporate them into their lesson plans.

Moreover, instead of restricting AI-PMP use, educators should encourage it while cautioning against overreliance, promoting a balanced view that highlights both benefits and drawbacks. AI-PMPs can enhance critical thinking by allowing students to compare answers and deepen their understanding of concepts. Furthermore, future research should include students from other university courses to better understand AI-PMPs' impact across various disciplines.

Research ethics

Author contributions

All authors made significant contributions to the study. Specifically,

Germalyn I. Abrigana: conceptualization, investigation, methodology, visualization, writing—original draft preparation, writing, review, and editing;

Roxan M. Caruana: conceptualization, investigation, methodology, visualization, writing—original draft preparation, writing, review, and editing;

John Rey L. Obcianal: conceptualization, investigation, methodology, visualization, writing—original draft preparation, writing, review, and editing;

Edenth Marie S. Templa: conceptualization, investigation, methodology, visualization, writing—original draft preparation, writing, review, and editing;

Judith M. Aleguen: supervision, validation, writing, review, and editing; and

Suzette T. Elladora: supervision, validation, writing, review, and editing.

All authors have read and agreed to the published version of the manuscript.

Artificial intelligence

During the course of this research and the writing of this manuscript, the researchers utilized artificial intelligence tools for specific tasks. The researchers utilized Grammarly's services to improve the writing's grammar, punctuation, and clarity, ensuring the final manuscript met high standards. Additionally, Microsoft Excel played a crucial role in data organization, solving equations, and creating data analysis presentations. Lastly, ChatGPT was utilized as a tool to help generate themes in the qualitative phase of the thematic analysis; however, it was still modified to maintain originality. Such tools helped enhance the efficiency of the research presentation.

Funding

The funding for this study is provided by the researchers' personal funds.

Informed consent statement

Informed consent was obtained from all research participants involved in this study. Participants were informed about the study's purpose, procedures, risks, and benefits. They were given the opportunity to ask questions, and their consent was obtained voluntarily. Confidentiality was ensured by assigning pseudonyms and handling all collected data securely. Participants were also informed that they could withdraw from the study at any time without penalty or obligation.

Data availability statement

The data are unavailable due to privacy or ethical restrictions.

Acknowledgements

This research would not have been possible without many individuals' incredible support and encouragement of many individuals. We thank Almighty God for His guidance and strength, Dr. Eingilbert C. Benolirao for permitting us to conduct this study, and our adviser, Dr. Virginia Albarracin, for her invaluable guidance. We are deeply grateful to our research professor, Ms. Judith Aleguen, and the panelists—Dr. Crysali Therese R. Dayaganon, Dr. Marichou L. Carreon, Dr. Suzette T. Elladora, and Dr. Fitzgerald C. Kintanar. To our families, co-researchers, participants, and classmates, we extend our gratitude for your unwavering support. We are truly grateful to everyone who made this work possible.

Conflicts of Interest

There is no conflict of interest in the study.

Appendix A

RESEARCH INSTRUMENT A
Quantitative Survey Questionnaire

PART 1: PROFILE OF THE RESPONDENTS

Direction: Please fill in the needed information below.

Name (Optional): ____________________
Age: ____________________
Gender: ( ) Male ( ) Female ( )Others (please specify): ____________________
Program & Year: ____________________

1.1 Mathematics Performance (College and Advanced Algebra final grade: _________
1.2 Commonly Used AI-Powered Math Platforms Direction: Encircle the letter of your answer.
1.2.1 Do you use AI-Powered Math Platforms (AI-PMP)?

YES
NO

1.2.2. If yes, which certain app/s do you utilize? *(Check the box)*

Automath
Cameramath
Cheggy
Cymath
Gauthmath
Mathway
Photomath
Symbolab
Others (*if not mentioned, please specify*): ___________________________

1.3 Frequency of Using AI-Powered Math Platforms

How frequently do you utilize AI-PMP in:	Never (Not Utilized) 1	Sometimes (Slightly Utilized) 2	Often (Moderately Utilized) 3	Always (Highly Utilized) 4
1. answering your math exercises and seatwork;				
2. understanding math concepts and principles;				
3. answering your homework/ assignment;				
4. practicing/reviewing your previous lesson in math;				
5. advanced study and enriching learning?				

PART II. Assessment of the Use of AI-Powered Math Platforms

Directions: Please put a check mark (/) on the box that corresponds to the degree or extent to which you agree or disagree based on the given statements using the following scales:

4-Strongly Agree (SA)
3- Agree (A)
2-Disagree (D)
1-Strongly Disagree (SD)

A. **Accessibility-** (Adapted from Obina, J. et al., 2022 (1), and Research Made (2-5)) - refers to the development and implementation of features that promote equitable access and use for all students **The AI-PMPs:**	**1**	**2**	**3**	**4**
1. have simple features.				
2. offer multiple ways to access content, such as voice commands and keyboard input.				
3. are useful in accessing specific subjects/topics/courses.				
4. can be accessed even offline.				

5. are responsive and work well on different devices (e.g., tablets, smartphones, computers).				
B. Ease of Use (Adapted from Almaiah, M. A., et al., 2021 (1), Robin H., 2020 (2-3), Obina, J., et al., 2022 (4) and Researcher made (5-8) - refers to the platform's design and functionality, ensuring a user-friendly and intuitive experience for instructors and students. **The AI-PMPs:**				
1. have a user-friendly interface.				
2. are easy to navigate.				
3. offer clear instructions.				
4. provide a step-by-step process.				
5. are easy to use by different types of learners.				
6. have a fast response time.				
C. Accuracy - (Adapted from Tantri, S. N., & Patiro, S. P. S. (2024). (1-2), Almaiah, M. A., 2021 (3), and Research made (4-8) - refers to the correctness and precision with which the platform's algorithms and capabilities carry out mathematical assessments, evaluations, and adaptive learning procedures **The AI-PMPs:**				
1. identify and address learning gaps in math.				
2. provide reliable information.				
3. provide clear and well-structured solutions to math problems.				
4. provide solutions to math problems similar to what is found in the textbook.				
5. offer explanations that are comparable to the teacher's discussion.				
6. give precise supplementary resources.				
D. Privacy- (Adapted from Yilmaz, H. et al., 2023 (1-3) and Research made (4-5)) -refers to the protection and responsible management of users' personal information, data, and platform interactions **The AI-PMPs:**				
1. ensure the security of collected information.				
2. take adequate measures to protect the user's privacy.				
3. address concerns about the misuse of data.				
4. inform users of the importance of securing data.				

5. take measures to prevent unauthorized access to personal data.				

Appendix B

RESEARCH INSTRUMENT B

The Use of AI-Powered Math Platforms in Mathematics Learning

Qualitative Interview Guide Questions

Directions: Please answer the following questions.

Could you share specific examples of improvements in your math grades or understanding that you attribute to using AI-PMPs?

Have you faced any challenges in your math studies that the AI-powered platform helped you address or overcome? Can you provide examples?

When you consider your experience with AI-powered math Platforms, how would you say their impact on your academic performance compares to other methods or resources you have used to learn math?

Looking ahead, do you foresee any lasting effects on your academic performance in math resulting from consistently using AI-powered math Platforms? If so, how?

How does using AI-powered math Platforms contribute to your overall performance in math classes?

References

Abar, C. a. a. P., Santos, J. M. D. S. D., & De Almeida, M. V. (2024c). Contributes to the Integration Between Computational Thinking and Artificial Intelligence for Mathematics Education. In Lecture notes in networks and systems (pp. 290–299). https://doi.org/10.1007/978-3-031- 54256-5_27

Almaiah, M. A., Alfaisal, R., Salloum, S. A., Hajjej, F., Shishakly, R., Lutfi, A., Alrawad, M., Mulhem, A. A., Alkhdour, T., & Al-Maroof, R. S. (2022). Measuring Institutions' Adoption of Artificial Intelligence Applications in Online Learning Environments: Integrating the Innovation Diffusion Theory with Technology Adoption Rate. Electronics, 11(20), 3291. https://doi.org/10.3390/electronics11203291

Bannister et al., (2014). Flexible Conceptions of Perspectives and Representations: An Examination of Pre-Service Mathematics Teachers' Knowledge. International Journal of Education in Mathematics, Science and Technology: 2(3). https://doi.org/10.18404/ijemst.23592

Blikstein, P. (2018). Exploring Problem-Based Learning for Middle School Design and Engineering Education in Digital Fabrication Laboratories. Interdisciplinary Journal

Bringula et al., (2021). Mathematics Self-Concept and Challenges of Learners in an Online Learning Environment during the COVID-19 Pandemic. Smart Learning Environments, 8(1). https://doi.org/10.1186/s40561-021-00168-5

Chen, L., Zhao, Y., & Parker, E. (2025). The Impact of AI-Powered Adaptive Learning on Student Performance in Undergraduate Mathematics. *Frontiers in Humanities and Social Research*, *2*(3), 378–399. https://sprcopen.org/index.php/fhsr/article/view/424

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16(3), 297–334.doi:10.1007/bf02310555

Dabingaya (2022). Analyzing the effectiveness of AI-Powered Adaptive Learning platforms in mathematics education. Interdisciplinary Journal Papier Human Review, 3(1), 1–7. https://doi.org/10.47667/ijphr.v3i1.226

De Oliveira Andrade, E. A., Da Silva, I. P., & Pina, M. O. M. (2023). DIGITAL TECHNOLOGIES IN MATHEMATICS EDUCATION. Journal of Interdisciplinary Debates, 4(01), 97–122. https://doi.org/10.51249/jid.v4i01.1255

Downes, S.(2005). An introduction to connective knowledge. ResearchGate. https://www.researchgate.net/publication/248290359_An_Introduction_to_Connective_ Knowledge

Efendi, M. A., Panglipur, I. R., & Murtinasari, F. (2024). Identifying the use of artificial intelligence in math learning based on learning outcomes. At- Ta Lim Jurnal Pendidikan, 10(2), 53–59. https://doi.org/10.55210/attalim.v10i2.1689

Galabo, N. R, Abellanosa, G. G., & Gempes, G. P. (2018). The level of readiness in mathematics of first-year high school students of Cluster 6 Tugbok Secondary Schools: Basis for Intervention Program. International Journal of Humanities, Arts and Social Sciences, 4(1). https://doi.org/10.20469/ijhss.4.10005-1

Genckaya & Tan-Sisman (2021). The use of the history of mathematics in teaching-learning process: The perspectives of faculty members and teachers. Psycho-Educational Research Reviews. https://doi.org/10.52963/PERR_Biruni_V10.N2.17

Goldie, J. G. S. (2016). Connectivism: A knowledge learning theory for the digital age? Medical Teacher, 38(10), 1064–1069. https://doi.org/10.3109/0142159x.2016.1173661

Gulliford, A., & Miller, A. (2015). Raising early achievement in Math with A randomized control trial. Journalof Educational Psychology,111(2),284–298. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6366442

Halton, C. (2023, December 14). Diffusion of Innovations Theory: Definition and Examples. Investopedia. https://www.investopedia.com/terms/d/diffusion-of-innovations-theory.asp

Tsai, S. (2024, February 15). Photomath Review 2024. SCI Journal. https://www.scijournal.org/articles/photomath-review

InternationalMathematicsUnion(2023).Mathematics in Africa: Challenges and Opportunities. https://www.mathunion.org/fileadmin/CDC/cdcuploads/CDC_MENAO/Africa_Re port.pdf\

Johnson, L., Becker, S. A., Cummins, M., Estrada, V., Freeman, A., & Hall, C. (2016, February 1). NMC Horizon Report: 2016 Higher Education Edition. Learning & Technology Library (LearnTechLib). https://www.learntechlib.org/p/171478/

Kanvaria, V. K., & Srivastava, T (2025). Understanding Artificial Intelligence in Education: Mathematics Students ' Awareness and Perceptions of AI. *AI in Education: A*, 283. https://tinyurl.com/bdhyxnf4

Kay, R. (2022). Analyzing the use of mathematics apps in elementary school classrooms.Contemporary Educational Researches https://www.researchgate.net/publication/342617962

Kenas, J. (2023, November 20). Is Using Mathway Cheating? All you need to know about Mathway. LearnPar. https://learnpar.com/mathway-and-cheating/

Kuntz, V. H., Ulbricht, V. R., & Freitas, M. D. C. D. (2017). Knowledge and information in the connectivismtheory. DeletedJournal,5(11),180–193. https://doi.org/10.31686/ijier.vol5.iss11.876

Kurt, S. (2023, September 25). Connectivism Learning Theory - Educational Technology. Educational Technology. https://educationaltechnology.net/connectivism-learning-theory/

Martin (2017). The Fourth Industrial Revolution: AI and Automation. https://theobserverqiaa.org/the- fourth-industrial-revolution-ai-and-automation

McCalla, G. (2023). The history of artificial intelligence in education – the first quarter century. In Edward Elgar Publishing eBooks (pp. 10–29). https://doi.org/10.4337/9781800375413.00010

Melo, N. (2024). The Impact of AI-Powered Tutoring Platforms on Student Achievement in STEM Subjects: The Case of Cameroon. *Available at SSRN 5249691*.https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5249691

Mikhail, R. (2023). Key Performance Indicators for measuring and evaluating users' sensory perceptions and behaviors in learning spaces in higher design education. In Academia Press eBooks. https://doi.org/10.26530/9789401496476-174

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Msomi, A., & Bansilal, S. (2018). The experiences of first-year students in mathematics in using an e- learning platform at a university of technology. South African Journal of Higher Education, 32(5). https://doi.org/10.20853/32-5-2507

Narboux, J., & Durand-Guerrier, V. (2022b). Combining Pencil/Paper Proofs and Formal Proofs is a Challenge for Artificial Intelligence and Mathematics Education. In Mathematics education in the digital era (pp. 167–192). https://doi.org/10.1007/978-3-030-86909-0_8

Obina, J. et al. (2022). Math app utilization: its perceived effects on the academic performance of mathematics major students. European Journal of Education Studies,9(9). https://oapub.org/edu/index.php/ejes/article/view/4459

OECD (2019). https://www.oecd.org/pisa/publications/PISA2018_CN_PHL.pdf Of Educational Methodology,9(4), 685-695.https://doi.org/10.12973/ijem.9.4.685OfNew Hampshire. https://jontalle.web.engr.illinois.edu/uploads/298/HistoryMath-Burton.85.pdf

Parmar, D. (2023, September 11). 7 AI-Based Mathematics Learning Platforms for Students of All Levels. Geekflare. https://geekflare.com/ai-based-mathematics-learning-platforms/

Rogers, E. M. (1962). Diffusion of innovations, first edition. New York: Free Press Sabol, D. (2014).Photomath. https://photomath.com/en/about

Sangoniyi, S. O., Lukumon, G., & Maharaj, A. (2025). Harnessing AI-powered tools in mathematics education to improve problem-solving skills for economic and technological advancement. *COAST*, *7*(2), 1351-1357.https://www.ajol.info/index.php/coast/article/view/310489

Schappacher, N. (2022). Framing global mathematics: The international mathematical union between theorems and politics. Switzerland. Springer International Publishing, 20 pages. https://www.google.com.ph/books/edition/Framing_Global_Mathematics/

Seo et al. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. International Journal of Educational Technology in Higher Education, 18(1). https://doi.org/10.1186/s41239-021-00292-9

Shrivastava, A. (2018). Using connectivism theory and technology for knowledge creation in cross- cultural communication. Research in Learning Technology, 26(0). https://doi.org/10.25304/rlt.v26.2061

Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology& Distance Learning, 2,3–10. https://www.itdl.org/Journal/Jan_05/article01.htm

Soesanto, R. H., Dirgantoro, K. P. S., & Priyanti, N. (2022). Indonesian students' perceptions towards AI-based learning in mathematics. Journal on Mathematics Education, 13(3), 531 –548. https://doi.org/10.22342/jme.v13i3.pp531-548

Taani, O., & Alabidi, S. (2024b). ChatGPT in education: benefits and challenges of ChatGPT for mathematics and science teaching practices. International Journal of Mathematical Education in Science and Technology, 1–30. https://doi.org/10.1080/0020739x.2024.2357341

Tantri, S. N., & Patiro, S. P. S. (2024). The Roles of Subjective Norms and Accessibility in the Acceptance Model of Koperasi Karunika Online Application. Sistemasi, 13(3), 959. https://doi.org/10.32520/stmsi.v13i3.3590

Tegmark, M. (2017). Life 3.0: Being Human in the Age of Artificial Intelligence. https://www.goodreads.com/en/book/show/34272565

UNESCO (2022). Artificial intelligence in education. https://www.unesco.org/en/digital- education/artificial-intelligence

United Nations Children's Fund (2021). Adolescent engagement and skills acquisition in digital spaces: Understanding opportunities, empowerment, and inclusion online. https://t.ly/7Ygq

Vintere, A., Safiulina, E., & Panova, O. (2024). AI-based mathematics learning platforms in undergraduate engineering studies: analyses of user experiences. Engineering for Rural Development. https://doi.org/10.22616/erdev. 2024 23.tf216

Wang, Q., Anyi, C. L., Swain, V. D., & Goel, A. K. (2024c). Navigating AI Fallibility: Examining People's Reactions and Perceptions of AI after Encountering Personality Misrepresentations. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2405.16355

Williams, R. (2020). The Use of Digital Applications and Websites in Completing Math Assignments. www.academia.edu. https://tinyurl.com/mxk7c3c3

Xu, Z. (2024). AI in education: Enhancing learning experiences and student outcomes. Applied and Computational Engineering, 51(1), 104–111. https://doi.org/10.54254/2755- 2721/51/20241187

Yalalov, D. (2023, November 1). Top 15 AI-Based Mathematics Learning Platforms for Students and Teachers in 2023. Metaverse Post. https://mpost.io/top-ai-based-mathematics-learning- platforms-for-students/

Yıldırım, S. (2020). Investigation of academic studies on learning styles: A systematic review. HAYEF: Journal of Education, 17(1), 20–50. https://doi.org/10.5152/hayef.2020.1922

Yilmaz, H., et al. (2023). Student's perception of Chat GPT: A technology acceptance model study. International Educational Review. https://doi.org/10.58693/ier.114

Zhang et al. (2022). Automatic Correcting Mathematics Operating System based on AI. Electrotehnică,Electronică, Automatică, 70(1), 61–70. https://doi.org/10.46904/eea.22.70.1.1108007

Zhang, M., et al. (2015). Using math apps for improving student learning: An exploratory study in an inclusive fourth-grade classroom. TechTrends, 59(2). https://doi.org/10.1007/s11528- 015/0837-y

Zong, M., & Krishnamachari, B. (2023). Solving math word problems concerning systems of equations with GPT models. Machine Learning With Applications, 14, 100506. https://doi.org/10.1016/j.mlwa.2023.100506

Zotos, K. (2024). Computer Algebra Systems & Artificial Intelligence. BRAIN BROAD RESEARCH IN ARTIFICIAL INTELLIGENCE AND NEUROSCIENCE, 15(2), 427–436. https://doi.org/10.18662/brain/15.2/584