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Exploring preferred math learning tools for pre-service teachers

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Abstract

Pre-service teachers play an important role in teaching and influencing future learners. One of the important skills that prospective teachers must have is mathematical ability, so information about pre-service teachers' learning tool preferences in understanding mathematical concepts is crucial. This study aimed to identify pre-service teachers' learning tool preferences for understanding mathematical concepts. This study used mixed methods, quantitative and qualitative. Data collection was carried out by distributing questionnaires to 129 prospective teachers from mathematics and science education study programs, as well as elementary school teacher education at Mulawarman University. Quantitative questions used Likert scale-type questions, and qualitative used free-response questions to get an in-depth analysis. The results of this study showed a very weak correlation between learning aid preferences and the understanding of basic math concepts, but it increased considerably when linked to advanced math concepts. In addition, there is a difference in preference between male and female pre-service teachers, where males are more likely to favor tools such as AI or ChatGPT, while females prefer learning videos. This study was expected to provide valuable information for policymakers to provide facilities that support the learning needs of pre-service teachers.

Keywords: Math, Pre-service Teachers, Preferences, Learning Tools, Gender

Abstrak

Calon guru memainkan peran penting dalam mengajar dan memberikan pengaruh kepada peserta didik di masa depan. Salah satu kemampuan penting yang harus dimiliki calon guru adalah kemampuan matematika, sehingga informasi mengenai preferensi alat bantu belajar pada calon guru dalam memahami konsep matematika menjadi krusial. Tujuan dari studi ini adalah untuk mengidentifikasi bagaimana preferensi alat bantu belajar calon guru dalam memahami konsep matematika. Studi ini menggunakan metode campuran, kuantitatif dan kualitatif. Pengambilan data dilaksanakan dengan menyebarkan kuesioner kepada 129 calon guru yang berasal dari program studi pendidikan Matematika dan IPA, serta dari Pendidikan

Guru Sekolah Dasar di universitas Mulawarman. Pertanyaan kuantitatif menggunakan tipe pertanyaan skala Likert, dan kualitatif menggunakan pertanyaan respon bebas untuk mendapatkan analisis yang mendalam. Hasil studi ini menunjukkan korelasi yang sangat lemah antara preferensi alat bantu belajar dan pemahaman konsep matematika dasar, tetapi cukup meningkat saat dihubungkan dengan konsep matematika lanjutan. Selain itu, terdapat perbedaan preferensi antara calon guru pria dengan wanita, di mana pria lebih cenderung menyukai alat bantu seperti AI atau ChatGPT, sedangkan wanita lebih menyukai video pembelajaran. Melalui studi ini, diharapkan dapat menjadi informasi berharga bagi pengambil kebijakan untuk dapat menyediakan fasilitas yang mendukung kebutuhan belajar calon guru.

Kata kunci: Matematika, Calon Guru, Preferensi, Alat Belajar, Gender

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INTRODUCTION

Pre-service teachers play a crucial role in shaping future education as they will influence the character of future students. The faculty of teacher training and education in higher education is a place where pre-service teachers can develop their skills in teaching (Cummins & Asempapa, 2013). Pre-service teachers and educators should focus on increasing mastery of their subject. Pre-service teachers are required to have basic mathematics skills, even though they are not from a mathematics education study program. It is because of the important role of math in every subject in school (Milgram & Wu, 2005). There is a relationship between students' ability to solve everyday problems using mathematical concepts and students' learning motivation (Sholeha et al., 2022). In this technological age, the application of mathematics extends across numerous fields, making it an essential predictor of children's readiness for formal schooling, surpassing even emotional and social skills (Sarama, 2018).

However, mathematics is often perceived as a challenging subject by many students. This perception underscores the importance of pre-service teachers having a positive and competent understanding of mathematics. When pre-service teachers recognize the significance of mathematics, they are more likely to convey its necessity and relevance to their students, fostering confidence in learning the subject. Yet, many pre-service teachers lack the strategies to teach mathematics effectively (Boyd et al., 2014). This gap highlights the need for these teachers to apply mathematical concepts to real-world situations, enabling students to grasp the practical applications of math. Teachers must be adept at translating complex mathematical ideas into comprehensible representations, which necessitates training in various representation skills such as story problems, visual aids, and practical tools (Siregar, 2017).

To facilitate this, many pre-service teachers use math tools to simplify the learning of mathematical concepts. These tools, which include concrete objects designed to embed and enhance understanding, are essential in teaching mathematics. These learning tools include books, educational apps, learning videos, and artificial intelligence (AI). Textbooks serve as crucial instructional media, essential both inside and outside the classroom (Efendi, 2009). With interactive software, educational apps are made to improve learning and are frequently utilized on portable devices like tablets and smartphones (Outhwaite & Herwegen, 2023). Educational apps (like GeoGebra) exemplify effective mathematical aids, offering various features that help visualize and construct mathematical concepts (Tanzimah, 2019). Learning videos present material in engaging formats, supporting both numeracy and digital literacy skills (Winarni et al., 2021). AI can increase learning effectiveness by making learning more personalized with individual students (Kengam, 2020). In school, AI such as ChatGPT is often used by students. According to Alafnan et al. (2023), ChatGPT provides an alternative for generating basic findings that the user can generate as often as they'd like. Additionally, ChatGPT assists learners in gaining the self-assurance and abilities needed to excel in the classroom (Diantama, 2023). Research has underscored the importance of integrating digital technologies in mathematics education. Engelbrecht & Borba (2024) identified significant advancements in the use of digital tools like computer algebra systems and dynamic geometry packages, which shift the focus from technical manipulation to conceptual understanding. Similarly, Lynch (2006) highlighted that tools such as graphical calculators and educational software enhance conceptual understanding and reduce cognitive load during problem-solving. Despite extensive studies on students' preferences for math learning tools, there is a lack of research focusing specifically on pre-service teachers' preferences. This study aims to fill that gap by examining the preferences of pre-service teachers regarding learning aids for mathematical concepts.

The idea of this study is to provide information to policymakers and educators about the preferences of learning aids in pre-service teachers so that they can make policies or systems that can maximize and support learning in pre-service teachers. Maximizing the learning of pre-service teachers will also have an impact in giving them ideas and systems that they can apply to their students when they enter the school world. This study is expected to improve the quality of Indonesian education learning in the future, especially in understanding mathematical concepts.

METHODOLOGY

This study aimed to provide in-depth information on the preferences of mathematics learning aids among pre-service teachers. This study utilized mixed methods, quantitative and qualitative, concurrent time orientation (Johnson & Christensen, 2014). Measurement of the validity of the questionnaire was carried out using the Pearson correlation test. This analysis was done by correlating each item's score on the questionnaire with the total score. After the measurement process, it was found

that all questionnaire items were valid. Measurement of the reliability of the questionnaire was carried out using Cronbach's Alpha statistics. After the measurement process, the Cronbach's Alpha value is 0.853. This indicates that the questionnaire has good internal consistency.

In July 2024, a survey was conducted among 129 active pre-service teachers who are currently studying and come from the Mathematics and Science Teacher Education and Primary School Teacher Education (PSTE) of Mulawarman University, Indonesia, utilizing purposive sampling. Pre-service teachers from the study programs consisted of 55 mathematics pre-service teachers, 52 physics pre-service teachers, 3 chemistry pre-service teachers, 12 biology pre-service teachers, 2 computer/informatics pre-service teachers, and 5 primary school pre-service teachers. The study programs were selected because they often use mathematical concepts in teaching and learning activities (mathematics and PSTE) or require a good understanding of mathematics to understand important concepts in their fields (Physics, Chemistry, Computer/Informatics, and Biology).

The survey employed a mixed-methods approach: quantitatively, it utilized Likert scales ranging from 1 (Strongly Disagree), 2 (Disagree), 3 (Neither Agree nor Disagree), 4 (Agree), to 5 (Strongly Agree) to assess perceptions, and qualitatively, it featured open-ended questions to explore the respondents' detailed views and experiences (Johnson & Christensen, 2014). Before analyzing the frequency and impact scores of math learning tools, a non-parametric Kruskal-Wallis H test was conducted to assess significant differences in the preferences for using learning tools across various study programs. Subsequently, the scores of frequency and impact of math learning tools can be calculated using Equation 1, where n_1 represents the number of participants who selected Strongly Disagree, n_2 the number of participants who selected Disagree, n_3 the number of participants who selected Neither Agree nor Disagree, n_4 the number of participants who selected 'Agree,' and n_5 the number of participants who selected 'Strongly Agree.' The interpretation of the scores can be seen in Table 1 (Putri & Suryati, 2016).

$$\text{Score} = \left(\frac{(n_1 \times 1) + (n_2 \times 2) + (n_3 \times 3) + (n_4 \times 4) + (n_5 \times 5)}{(n_1 + n_2 + n_3 + n_4 + n_5) \times 5} \right) \times 100 \quad (1)$$

Table 1. Score Interpretation

Score	Category	
	Frequency	**Impact**
0 ≤ score < 20	Very rare	Very low
20 ≤ score < 40	Rare	Low
40 ≤ score < 60	Sometimes	Moderate
60 ≤ score < 80	Often	High
80 ≤ score ≤ 100	Very often	Very high

Pre-service teachers were also asked to give their perception of rating from 1 (very poor) to 5 (very good) their understanding of basic math concepts and advanced math concepts. Basic mathematical concepts include concepts such as basic calculation operations, basic properties of flat shapes, whole numbers and fractions, definitions of sine, cosine, tangent, linear equations, and basic statistics (material found mostly in elementary and junior high schools). Advanced math concepts include quadratic equations, polynomials, calculus, trigonometric identities and equations, functions and graphs of functions, and logarithms (the majority of material found in senior high school). After obtaining the data, continued with the correlation test between the two variables, each learning device with basic and advanced mathematics concept understanding. The correlation test was conducted using Spearman's rho test (Spearman, 1904). The questionnaire included a question on gender to explore the relationship between gender and learning tool preferences among pre-service teachers. The analysis of differences in learning tool preferences between males and females was conducted using the Mann-Whitney U test (Fagerland, 2012). Then to further determine whether there is a significant difference in the frequency of use of learning tools within one gender, the Friedman test was conducted (Friedman Milton, 1940). Finally, there was an open-ended question (qualitative analysis) regarding pre-service teachers' impressions of the effectiveness of each learning tool, "What is your impression of the effectiveness of each learning tool you use on your understanding of mathematical concepts?". Respondents who answered the quantitative question were the same respondents who answered the qualitative question, so they were included in the identical sample relation. The answers from each respondent were analyzed in more depth and linked to the results of quantitative data analysis and previous research.

RESULT AND DISCUSSION

In order to see how the preference for using learning tools in terms of the study program, conducted Kruskal-Wallis H test. This test will indicate if there is a significant difference between the preference for the use of learning tools between each study program of Mathematics Education, Physics Education, Chemistry Education, Biology Education, Computer or Informatics Education, and Elementary School Teacher Education. The results can be seen in Table 2.

Table 2. Results of the Kruskal-Wallis H Test for Differences in Preferences for Using Learning Tools Across Study Programs

Learning Tools	Kruskal-Wallis H	Significance
Books	1,316	0,933
Educational Apps	1,377	0,927
Learning Videos	10,293	0,067
AI	1,885	0,865

At a 5% significance level, the results in Table 2 indicate no significant

difference in the use of various learning tools across the study programs. This may be explained by the similar educational needs in these fields, which share foundational mathematical concepts and problem-solving methods. Additionally, the standardized teaching approach to mathematics in higher education likely contributes to a uniform preference for learning tools across the programs.

Preferences of Learning Aids for Pre-service Teachers in Understanding Mathematics Concepts

Table 3 shows the frequency of learning tools used by pre-service teachers for understanding mathematical concepts. The results presented in Table 3 indicate that among the tools assessed, learning videos received the highest frequency score of 79.0, suggesting they are the most commonly used resource. This may be due to the interactive and visual nature of videos, which can simplify complex mathematical concepts. Educational apps and artificial intelligence (AI) tools also showed high-frequency scores, at 64.7 and 66.7, respectively, reflecting the growing reliance on technology for learning. Books, while still frequently used with a score of 60.8, were ranked slightly lower, likely due to the increasing preference for digital and interactive tools.

Table 3. Frequency of Learning Tools Usage for Understanding Mathematical Concepts

Learning Tools	Frequency Score	Interpretation
Books	60.8	Often
Educational Apps	64.7	Often
Learning Videos	79.0	Often
AI	66.7	Often

Table 4. Impact of Use of Learning Tools for Understanding Mathematical Concepts

Learning Tools	Impact Score	Interpretation
Books	71.1	High
Educational Apps	73.5	High
Learning Videos	85.7	Very High
AI	69.5	High

Table 4 highlights the perceived impact of various learning tools on pre-service teachers' understanding of mathematical concepts. Learning videos stand out with the highest impact score of 85.7, categorized as very high. This underscores the effectiveness of visual and auditory learning aids in simplifying complex concepts and enhancing comprehension. Educational apps also showed a high impact score of 73.5, indicating that interactive learning technologies are valuable tools for promoting deeper understanding. Books, traditionally fundamental in education, continue to have a high impact with a score of 71.1, although they rank lower than more dynamic, tech-driven tools. Artificial intelligence (AI) tools, while also rated with a high impact score of 69.5, suggest potential for further integration into learning environments. Overall, these results reveal that while traditional resources like books remain effective, digital

tools such as learning videos and educational apps are increasingly seen as more impactful in aiding mathematical learning.

This study has also summarized the free responses of pre-service teachers and analyzed their perceptions of learning aids in understanding mathematical concepts. Reading media, such as books, can be divided into printed and digital forms. By reading books, one can gain much of indirect experience (Efendi, 2009). Previous studies show that based on reading interest and learning experience, students tend to choose digital literature reading media. Meanwhile, in the aspect of excellence and mastery of literary concepts, students prefer printed literature (Widiastuti et al., 2022). The pre-service teachers also pointed out the weaknesses of textbooks, particularly their lack of interactivity. They found that some concepts were difficult to understand solely from books, as there was no immediate way to ask questions when something was unclear. Some representative reasons given include.

"Very complete in providing explanations and examples of problems but less effective and there are some concepts that are difficult to understand without additional help"

"Structured, lots of exercises, but less interactive"

"Textbooks are an excellent resource for learning basic concepts and understanding more complex material. They usually include detailed explanations, examples, and practice problems, which can help students understand and remember the material better"

"Books are more comfortable to read by eye"

Then for learning aids in the form of learning applications, pre-service teachers convey the advantages of learning applications, which are more coherent and structural, and interesting with the elements of gamification. Previous studies found that the use of weblog-based Android applications is more effective than learning without using Android application media (Amin, 2015). Previous studies have also found that the use of interactive applications can provide benefits for early math learning in children (Riady, 2021). However, pre-service teachers also expressed the obstacles of learning applications such as requiring access to the device and some requiring additional costs. Some also complained that it was too complicated to use.

"Learning applications such as Khan Academy are more coherent and clear the direction of learning"

"Interactive and fun, but requires technology and cost"

"Educational apps are easy to use and interactive, especially the gamification feature helps to improve learning consistency"

"Educational apps allow direct interaction with math concepts, but need access to a device."

"Educational apps are mostly paid, but there are still some free features provided, those free features help me in learning"

Then, for learning aids in the form of learning videos, pre-service teachers convey the advantages of learning videos, which are widely available and easily accessible, as well as interesting and easy-to-understand explanations. Learning videos such as YouTube videos have the ability to attract students' attention through interesting visual and audio learning (Alqahtani & Abdelrahman, 2014; Hollywood, 2014; Mardianto & Prayitno, 2020; Rahmatika et al., 2021). This is supported by previous research, which says that students who are treated with learning using YouTube enjoy learning classes more and are proven to be able to improve student performance (Dorji, 2023). YouTube also provides stimulus and different approaches to understanding new material concepts (Alqahtani & Abdelrahman, 2014). YouTube has also been shown to increase student motivation to learn over traditional approaches (Alqahtani & Abdelrahman, 2014; Bravo et al., 2011; Choi & Johnson, 2005). However, the constraints of video teaching, such as YouTube, cannot provide interactive learning, and there is no question-and-answer feature. The long duration of learning videos can also reduce the level of focus.

"Learning videos are now widely available and easily accessible, so the variety of explanations is more varied, which can help me in learning"

"It is helpful to understand learning concepts by seeing and hearing and can be played repeatedly, but it is less interactive and it is not always possible to ask direct questions."

"Widely available on various platforms and easily accessible, and provides clear and detailed explanations according to learning style"

"Visuals and audio help, but can be long and lack focus"

"For learning videos, it can be repeated many times but if for example, you don't understand, you can't ask directly"

Then for learning aids in the form of AI, pre-service teachers revealed that AI is very interactive and answers any asked questions. AI is also able to provide detailed explanations and use well-understood language. This is also reinforced by previous studies, which revealed the advantages of AI in increasing the personalization of learning, thus improving learning outcomes (Baidoo-Anu & Owusu Ansah, 2023; Winkler & Soellner, 2018). However, one of the disadvantages of AI (such as ChatGPT) is that it requires the right keywords or prompts to generate the desired answers. In addition, previous studies also urge lecturers and teachers to be more aware of the proper regulations in the use of AI, to prevent negative effects that can arise (Maulana & Darmawan, 2023).

"AI can be asked anything (so it can answer all questions) and if for example, we want to ask for an explanation along with an example, AI can also provide it even though only writing appears"

"AI has no limitations and answers many questions with detailed and easy-to-understand answers"

"AI like ChatGPT is very helpful but requires precise and detailed prompts"

"For the use of Artificial intelligence (AI) in understanding math concepts, it is easier to understand, AI provides complex and detailed explanations"

The Relationship between Learning Tools Used by Pre-service Teachers and Understanding of Mathematical Concepts

The usage of learning tools and the understanding of mathematical concepts were measured on an ordinal scale from 1 to 5. To assess the correlation between these two variables, Spearman's rho test was applied. The results for basic math materials are presented in Table 5. As shown, only the use of learning videos significantly correlates with the understanding of basic math concepts, though the correlation is weak. The use of other learning tools shows less significant correlations with the understanding of basic mathematics. This may be because pre-service teachers have already acquired a solid understanding of basic math through classroom learning, reducing their reliance on external learning tools for these topics.

Table 5. Correlation of Learning Tools to Basic Understanding

Learning Tools	Correlation Coefficient	Significance	Interpretation
Books	0.121	0.171	Very Weak
Educational Apps	0.013	0.885	Very Weak
Learning Videos	0.273	0.002	Weak
AI	-0.083	0.349	Very Weak

Table 6. Correlation of Learning Tools to Advanced Mathematics Concepts

Learning Tools	Correlation Coefficient	Significance	Interpretation
Books	0.214	0.015	Weak
Educational Apps	0.130	0.141	Very Weak
Learning Videos	0.307	0.000	Weak
AI	-0.036	0.683	Very Weak

The results of correlation measurements for advanced mathematics materials can be seen in Table 6. From the table, the use of books and learning videos, significantly correlate with the understanding of advanced mathematics concepts, although the level of correlation is weak. The rest, the use of other learning tools less significantly correlates with the understanding of advanced mathematics concepts. Therefore, there is an increased correlation between the use of learning tools from basic mathematics to advanced mathematics. This makes sense given that advanced math materials require high reasoning, so the use of learning tools is vital.

The Effect of Gender on Preferences for Learning Tools Used to Understand Mathematics Concepts

In order to investigate the preference for using learning tools in terms of gender, this

research study employs the Mann-Whitney U test. This test indicates whether there is a significant difference in the preference for using study tools between males and females. The test results can be seen in Table 7.

Table 7. Preference of Learning Tool Use in Terms of Gender

Learning Tools	Mann-Whitney U	Significance
Books	1428.5	0.178
Educational Apps	1339.0	0.066
Learning Videos	1510.0	0.367
AI	1239.5	0.019

Table 7, it can be observed that at the 5% significance level, only AI differs significantly in its usage preference between males and females. For the other tools, there is no significant difference in the usage preference between males and females. In addition, it can also be concluded how each gender group chooses their preferred learning tools. Using the Friedman test, it can be seen whether there is a significant difference in preference among learning tools between each gender. From the data obtained, preferences between the various learning tools were ranked based on the mean rankings obtained from the Friedman test for each gender separately. The result can be seen in Table 8.

Table 8. The Difference in Preference for the Use of Learning Tools between Men and Women Using the Friedman Test

No.	Learning Tools	Average Frequency of Use of Learning Tools	
		Male	Female
1	Books	1.88	2.10
2	Educational Apps	2.31	2.54
3	Learning Videos	2.86	3.15
4	AI	2.96	2.22
Chi-Square		21.663	49.710
Significance		0.000	0.000

It can be seen that at the 5% significance level, there is a significant difference in the preference for using learning tools for both male and female pre-service teachers (Table 8). In this case, male pre-service teachers have a preference for using AI when compared to other learning tools. This could be because men find it easier to learn by emphasizing hands-on activities such as practicing or moving their fingers (Amin, 2018), and AIs such as ChatGPT can provide interactive materials as well as immediate answers without the need for special formulas (Kalla & Kuraku, 2023). Previous studies have also revealed that ChatGPT provides interactive learning that can increase learning motivation (Dilzhan, 2024; Songsiengchai et al., 2023; Zhou & Li, 2023). On the other hand, female pre-service teachers have a preference for using learning videos when compared to other learning tools. This is consistent with previous studies which found that women prefer learning methods that emphasize persuasive and communal communication such as lectures, presentations, and so on (Amin, 2018).

CONCLUSION

This study analyzed pre-service teachers' preferences for learning aids in understanding mathematical concepts. Likert scale analysis results show that pre-service teachers routinely use a variety of learning aids and agree that they have a positive effect on understanding math concepts, especially visually and audibly appealing learning videos. For basic math concepts, most of the tools showed a very weak correlation as understanding was gained through classroom learning. In contrast, for advanced math concepts, books and learning videos showed a weak correlation, while educational apps and AI showed a very weak correlation. Gender-based analysis revealed that male teacher candidates preferred AI, while female pre-service teachers preferred learning videos and innovative communication activities. This research successfully provides policymakers and educators with relevant information on prospective teachers' learning tool preferences. By understanding the tools that are effective and preferred by pre-service teachers, education policies and systems can be adjusted to support and maximize their learning process. Appropriate facilities and aids not only improve pre-service teachers' understanding of mathematical concepts, but also prepare them to apply similar methods in their future teaching. The positive impact of this research is expected to improve the quality of mathematics learning in Indonesia, both for pre-service teachers and students, and support the development of an education system that is more effective and responsive to today's educational needs. The deepening of the pre-service teachers from social or language backgrounds are interesting to investigate further, considering the scope of mathematical materials and concepts used in different portions and levels of difficulty. Therefore, suggestions for future research can discuss the differences in learning tool preferences between science pre-service teachers and social, legal, and language pre-service teachers in understanding mathematical concepts.

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