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Analysis of Differences in the Level of Understanding of Mathematical Concepts Between Students Using Digital Learning Media and Students Using Textbooks

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Abstract: This study aims to analyze the difference in the level of understanding of mathematical concepts between students using digital learning media and students using textbooks. This research is quantitative in nature with a survey approach. The research subjects consisted of 63 students from junior and senior high schools. The research instrument used was a Likert scale questionnaire consisting of 10 items for digital media (X1) and 10 items for textbooks (X2). The data obtained were analyzed using the t-test. The results of the data analysis showed a t-value of 3.415 with a significance level (sig) of 0.002. These findings indicate a significant difference in the level of understanding of mathematical concepts between the two groups of students. The implication of this research is the importance of considering the integration of digital learning media in the mathematics learning process to enhance the effectiveness of students' understanding of mathematical concepts. Further research could focus on identifying the factors influencing these differences and developing more innovative and adaptive digital learning methods to support a more effective mathematics learning process.

Keywords: Understanding Mathematical Concepts, Digital Learning Media, Textbooks.

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A. INTRODUCTION

Understanding mathematical concepts plays a key role as the foundation for students' learning abilities in this field. As a discipline that requires a deep understanding of its fundamental concepts, mathematics not only teaches computational skills but also fosters analytical and critical thinking (Durachman & Cahyo, 2020). Thus, students' ability to comprehensively understand mathematical concepts greatly influences their success in solving problems and applying these concepts in real-world situations. In the context of mathematics learning processes, digital learning media and textbooks have become two primary methods used to deliver course materials. Digital learning media offer various interactive features, dynamic visualizations, and the ability to adapt to individual learning styles (Saman, 2023). Meanwhile, textbooks continue to serve as classic reference sources in mathematics education, presenting information in a structured and cohesive format. Therefore,

the roles of these two learning methods in shaping understanding of mathematical concepts are the main focus of this research.

Mathematical content often involves abstract concepts and complex information processing, which can pose a barrier for some students to fully comprehend (Hadzami & Maknun, 2022). Additionally, each individual student has variations in learning styles and preferences, which can affect the effectiveness of the learning process (Adiningsih et al., 2023). Some students may be more responsive to visual or interactive approaches, while others may prefer more structured, text-based learning. Mismatch between students' learning styles and the teaching methods applied can result in a decrease in understanding mathematical concepts and impact their overall academic performance. Therefore, understanding individual differences in students' learning styles and preferences is a key factor in developing effective and inclusive learning strategies.

Research on the differences in understanding mathematical concepts between students using digital learning media and those using textbooks is of significant relevance in mathematics education. With the advancement of technology, the use of digital learning media has become increasingly popular in delivering instructional materials, including in the field of mathematics. These media often offer various interactive features, dynamic visualizations, and flexibility to adapt to students' learning needs and preferences (Kusumadewi & Neolaka, 2020). On the other hand, textbooks are still considered one of the primary sources of information in mathematics education, presenting materials in a structured and detailed format (Fan et al., 2021). Therefore, analyzing the differences in understanding between these two groups of students can provide valuable insights into the effectiveness of both learning methods. Findings from this analysis can serve as a basis for developing more inclusive and adaptive mathematics learning strategies, in line with technological advancements and current learning needs. Digital learning media play a vital role in enhancing the presentation of mathematical content through interactivity, visualization, and adaptability.

Research highlights the importance of interactive multimedia in facilitating the learning process of mathematics by connecting abstract concepts with real-world situations (Octavia & Yulianti, 2022; Pujakusuma & Pramuditya, 2023). Additionally, the integration of dynamic interactive software enhances core mathematical abilities such as problem-solving and linking various representations, emphasizing the role of visualization in a dynamic mathematics learning environment (Atmaja, 2020). Furthermore, the development of interactive media such as electronic worksheets has been proven to enhance students' understanding and motivation in learning complex mathematical concepts, such as linear equation systems (Dockendorff, 2019). Overall, the advantage of digital learning media lies in its ability to effectively engage students, provide visual representations, and adapt to diverse learning styles, thereby enhancing the learning experience in mathematics.

Textbooks play a key role in mathematics education by aiding in the formation of student understanding (Gracin & Krišto, 2022). They present structured tasks that influence mathematical thinking and provide opportunities for learning (Otieno & Povey, 2023).However, traditional textbooks often emphasize closed-answer patterns and may lack the interactive and dynamic features of digital platforms (Incikabi et al., 2023).Although

textbooks provide systematic learning structures and aid skill development (Fernández & Caballero, 2017), they may be less capable of providing the interactivity and adaptability needed for a personalized learning experience. The static characteristics of textbooks may limit students' ability to face mathematical challenges in real-life situations and hinder their ability to apply mathematical concepts in various scenarios. Despite serving as a primary reference source, textbooks can enhance their utility by integrating stronger interactive elements to increase student engagement and meet their diverse learning needs.

Studies have explored differences in understanding mathematical concepts between users of digital learning media and textbooks. Research has indicated that digital modules can enhance students' ability to comprehend mathematical concepts, although they may not fully address relational understanding (Fauziyah et al., 2022; Geng et al., 2024). Additionally, the use of e-book systems in K-12 education has revealed various patterns of learning behavior, with students employing different strategies based on their performance levels. Students with improved performance tend to utilize deeper learning strategies, such as integrating information from different pages, while those with declining performance lean towards shallow cognitive processing strategies (Simbolon et al., 2022).Furthermore, meta-analytic findings suggest that instructional videos have a significant positive impact on mathematical abilities compared to conventional methods, especially when considering factors such as flipped classroom models and educational levels (Riaddin, 2022).

Analysis of these studies indicates that although digital learning media offer various advantages in presenting mathematical materials, such as interactivity, visualization, and adaptability, traditional textbooks still play an important role in mathematics education by providing systematic learning structures. However, there is a gap in the use of traditional textbooks, which tend to emphasize closed-answer patterns and underutilize the interactive features of digital platforms, potentially not meeting the diverse learning needs of students. This highlights the need to enhance the integration of interactive elements in textbooks to increase student engagement and address the diverse challenges of teaching mathematics.

The purpose of this study is to analyze the difference in the level of understanding of mathematical concepts between students using digital learning media and those using textbooks. Thus, this research aims to provide deep insights into the effectiveness of both learning methods in assisting students in understanding mathematical concepts. Through a better understanding of these differences, it is hoped that more effective and inclusive learning strategies can be developed to enhance students' mathematical understanding and meet the diverse learning needs of students in an ever-evolving information technology era.

B. METHOD

The research method employed in this study is quantitative research with a survey approach. The primary objective of this research is to analyze the difference in the level of understanding of mathematical concepts between students using digital learning media and those using textbooks. The research subjects consist of 63 junior and senior high school students. The research instrument used is a questionnaire, consisting of 10 questions for digital learning media (X1) and 10 questions for textbooks (X2). This questionnaire employs a Likert

scale with five response options, ranging from strongly disagree (scored 1) to strongly agree (scored 5). The indicators for the digital learning media questionnaire (X1) encompass aspects such as mathematical concept comprehension, learning interest, interactive learning experiences, motivation, and application of mathematical concepts in daily life. Meanwhile, the indicators for the textbook questionnaire (X2) include aspects such as mathematical concept comprehension, learning preferences, exercises, comprehension evaluation, and exam preparation. The research was conducted through several stages, including the preparation of the questionnaire according to the research variable indicators, distribution of the questionnaire to respondents via social media, data tabulation and analysis, and interpretation of data and conclusion drawing based on the data analysis results. The data analysis technique used is descriptive statistics and the Student's t-test, employing the JASP software. The conclusion drawing criteria are if the Sig value < 0.05, then H0 is rejected, indicating a difference in the level of understanding of mathematical concepts between students using digital learning media and those using textbooks.

C. RESULTS AND DISCUSSION

Data collection was conducted through distributing questionnaires over a period of 10 days to junior and senior high school students, with a total of 63 respondents, consisting of 30 students learning using digital books and 33 students learning using textbooks. Participants were asked to respond to questions using a rating scale ranging from strongly agree to strongly disagree, according to their individual perceptions and perspectives. The questionnaire results obtained, as shown in Table 1, formed the main basis for analyzing and interpreting response patterns and preferences from the sample involved in the study.

Table 1. Descriptive Statistics

	Digital (X1)	**Book (X2)**
Valid	30	33
Missing	4	1
Median	82.000	70.000
Mean	79.200	71.152
Std. Deviation	8.462	9.644
Variance	71.614	93.008
Minimum	56.000	46.000
Maximum	92.000	96.000

From the presented data, there is a significant difference in the characteristics of understanding mathematical concepts between students using digital learning media and those using textbooks. The average understanding of mathematical concepts among students learning with digital media (79.200) consistently exceeds that of students using textbooks (71.152). This indicates the potential positive influence of using digital media in enhancing understanding of mathematical concepts. Additionally, the difference in median between the two groups also reflects a significant gap, with the median of students using digital media (82.000) significantly higher than that of students using textbooks (70.000). The lower standard

deviation in the group of students using digital media (8.462) compared to the group of students using textbooks (9.644) indicates a lower level of data dispersion in the former group, confirming the higher consistency of understanding mathematical concepts among students using digital media.

Statistical analysis involving means, medians, and standard deviations provides a deeper understanding of the characteristics of the distribution of understanding of mathematical concepts among the two groups of students. The significant differences in these descriptive statistics provide further support for previous findings indicating differences in the level of understanding between the two learning methods. Thus, this data can serve as a strong basis to support arguments about the effectiveness of digital learning media in enhancing understanding of mathematical concepts. This underscores the importance of further research and development in the use of technology in the context of mathematics education to optimize student learning outcomes.

Table 2. Paired Sample T-Test Hypotesis Test

Measure 1	Measure 2	t	df	p
Digital (X1)	Book (X2)	3.415	29	0.002

The analysis results in Table 2 indicate a significant difference in the level of understanding of mathematical concepts between students using digital learning media and those using textbooks. The t-test value of 3.415 with a p-value of 0.002 signifies that this difference is not merely by chance. Rejecting the null hypothesis (H0) with a significance value (Sig) of less than 0.05 confirms that there is a significant difference in the understanding of mathematical concepts between the two groups of students. This suggests that the use of digital learning media may have a different impact on the understanding of mathematical concepts compared to the use of textbooks, which could have important implications in the context of developing more effective mathematics learning methods.

Understanding mathematical concepts is a critical aspect of mathematics education that influences students' ability to apply these concepts in different contexts. The results of this analysis highlight the importance of digital learning media in enhancing students' understanding of mathematical concepts. By rejecting the null hypothesis, these findings indicate that instructional approaches utilizing digital media may be more effective in facilitating students' understanding of mathematical content. Therefore, these results provide impetus to further consider integrating digital learning media in mathematics curriculum design and developing teaching strategies to enhance the effectiveness of understanding mathematical concepts for students.

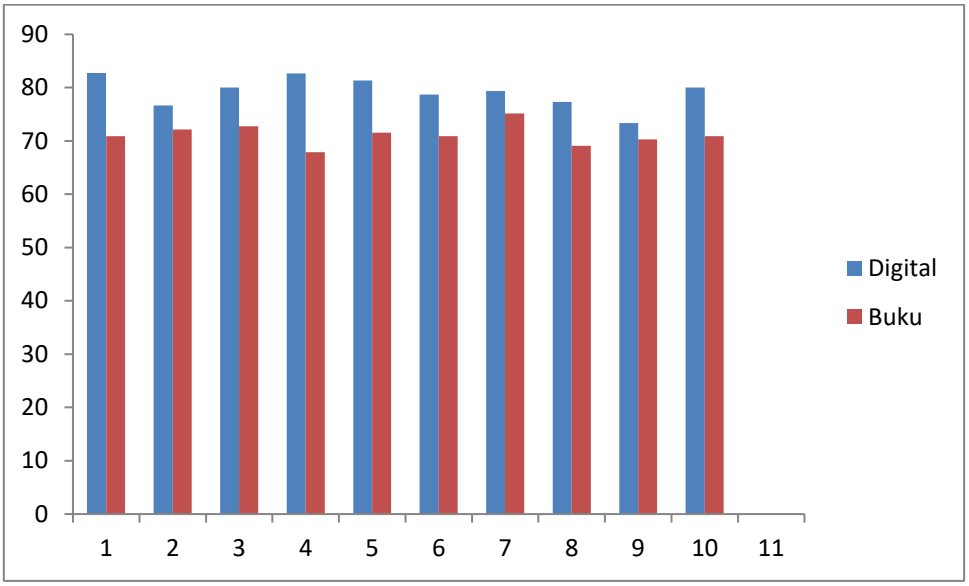

Figure 1. Average Student Assessment Results Based on Indicators

Figure 1 depicts the assessment results of students' understanding of mathematical concepts using digital media and textbooks. There is a noticeable difference in the emphasis on understanding various aspects of mathematics between these two learning methods. In the use of digital media, the highest average scores are found in indicators 1 and 4, with scores of 82.67, while the lowest average score is found in indicator 9, with a score of 73.33. This indicates that students tend to have a better understanding of concepts presented through digital media, especially in aspects emphasized in indicators 1 and 4. On the other hand, in the use of textbooks, the highest average score is in indicator 7 with a score of 75.15, while the lowest average score is in indicator 4 with a score of 67.88. This suggests that textbooks may be more effective in presenting certain concepts, as reflected in indicator 7, but less effective in facilitating understanding in indicator 4.

This analysis provides deeper insights into how students respond to mathematical content presented through digital media and textbooks, and identifies which indicators may require further attention in both learning methods. The difference in the emphasis on understanding mathematical concepts between digital media and textbooks highlights the importance of considering students' characteristics and learning needs in designing effective teaching strategies. Therefore, these findings can provide a foundation for teachers and curriculum developers to select and integrate teaching methods that best suit students' needs and characteristics in efforts to enhance their understanding of mathematical concepts.

D. CONCLUSIONS AND SUGGESTIONS

Based on the data analysis conducted, a t-test value of 3.415 with a significance level (Sig.) of 0.002 was found. This result indicates a significant difference in the level of understanding of mathematical concepts between students using digital learning media and those using textbooks. These findings suggest that the use of digital learning media has a different impact on understanding mathematical concepts compared to the use of textbooks. Therefore, to

enhance the effectiveness of mathematics education, it is important for educators and curriculum developers to consider integrating digital learning media into the learning process.

For future research, it is recommended to further investigate the factors that may influence the difference in the level of understanding of mathematical concepts between these two learning methods. For example, in-depth research could be conducted on student characteristics, such as learning styles and technology proficiency, and their influence on the effectiveness of learning using digital media. Additionally, further research could focus on the development of more innovative and adaptive digital learning methods, as well as measuring their long-term impact on students' understanding of mathematical concepts. Thus, this further research is expected to provide more comprehensive insights to support the development of more effective mathematics learning strategies in this digital era.

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