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The Effect of Genially-Based Interactive Media on Students' Understanding of Mathematical Concepts

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ABSTRACT

This study aimed to determine the effect of using Genially interactive learning media on students' understanding of mathematical concepts among grade X students at MAN 3 Medan. The research employed a quasi-experimental method with a pre-test and post-test design involving two groups: an experimental group that used Genially-based interactive learning and a control group that received traditional instruction. Two classes were randomly selected as samples. The data were collected using pre-test and post-test instruments that had been validated and tested for reliability. The results showed that students who were taught using Genially achieved higher post-test scores than those taught through conventional methods, with a mean difference of 13.4950 > 1.99656. Statistical analysis revealed a significant difference between the two groups, suggesting that the use of Genially interactive media has a positive impact on students' comprehension of mathematical concepts. The findings suggest that integrating Genially into classroom learning can enhance engagement, motivation, and conceptual understanding, making abstract mathematical material more concrete and accessible for students. Overall, the study highlights the potential of digital interactive media as a powerful tool for enhancing learning outcomes in mathematics education.

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1. INTRODUCTION

Mathematics is one of the subjects taught in formal educational institutions as part of efforts to improve the quality of education. However, this subject is often considered difficult by students, resulting in low interest in learning [1]. Mathematics itself is a science that studies logic, form, structure, quantity, and relationships between concepts [2], and is generally abstract. This level of abstraction often presents a challenge for students to understand. Perceptions of mathematics' difficulty can lead to low interest in learning, lack of student participation in the learning process, and passivity in class. These difficulties are exacerbated by less meaningful learning, minimal student engagement, and the use of

ineffective learning media, which hinder students' understanding of mathematical concepts [3]. Therefore, it is essential to identify innovative teaching strategies and appropriate media that can make abstract mathematical concepts more concrete and easier to comprehend.

According to the Trends in International Mathematics and Science Study (TIMSS), Indonesian students' achievement in science is ranked 40th, which is still low compared to other countries. Meanwhile, in the 2006 Program for International Student Assessment (PISA), Indonesia's science score was ranked 50th out of 57 countries with a score of 393. In 2009, the score dropped to 383, placing Indonesia in 60th place out of 65 countries. In general, Indonesian students' achievement is still at a basic level and has not yet reached a higher level of thinking. The 2013 PISA results also revealed a concerning trend, with Indonesia ranking 35th out of 49 countries, and even among the bottom two ranks out of 65 countries [4], [5], [6], [7]. These data indicate that students' ability to understand and apply mathematical concepts remains below the expected global standard. Therefore, improving students' conceptual understanding has become a priority for education stakeholders in Indonesia.

Based on observations and interviews conducted with mathematics teachers at MAN 3 Medan, several findings were obtained. The school has a total of 11 study groups, each consisting of approximately 30 to 36 students. Overall, the mathematical ability of grade X students is categorized as lower-middle. This is reflected in the average score of Class X-7 students on the first-semester final examination, which was only 60. Out of 34 students, 19 had not yet achieved learning mastery, indicating that only about 44% were able to meet the school's Minimum Mastery Criteria (KKM), which is set at 70. This situation highlights that most students have not yet achieved the expected level of understanding in mathematics, underscoring the need for enhanced teaching methods and learning tools to support improved outcomes.

One of the causes of students' difficulties in learning mathematics is a lack of understanding or misinterpretation of mathematical concepts. Errors in conceptual comprehension at one educational stage may persist into subsequent levels, resulting in even more fundamental mistakes. This happens because mathematical concepts are interrelated and build upon one another [8]. Hence, when foundational concepts are misunderstood, students struggle to grasp advanced topics, leading to a cumulative learning gap. Strengthening conceptual understanding from an early stage is therefore essential for long-term mathematical competence.

The Ministry of National Education (2003) says that understanding ideas is a key math skill that students should learn. This can be seen in how well students understand the concepts they study, explain how these ideas are connected, and use them in different ways to solve problems accurately and efficiently. Additionally, Diana et al. [9] state that understanding ideas is crucial for grasping larger concepts and theories. To learn a theory, students need first to understand the basic ideas underlying it. Lacking a solid understanding of these concepts can lead to significant problems. Although it is very important, many students still struggle to develop this skill. Therefore, mathematics learning should focus not only on procedural fluency but also on developing a deep conceptual understanding that enables students to apply knowledge flexibly in various contexts.

One solution to this problem is to utilize interactive learning media as a teacher strategy in delivering diverse material. This approach can stimulate student interest and enhance learning. The use of interactive media also contributes to a more engaging learning process, facilitating student understanding. Through interactive tools, students can visualize abstract concepts, participate actively, and receive immediate feedback, which strengthens their comprehension and motivation.

Interactive media plays a crucial role in enhancing student understanding and positively impacting their learning outcomes [10]. Learning using interactive media tends to be more engaging, facilitates student understanding, and reduces boredom due to its game-like approach [11]. One such learning medium is Genially. His type of media not only supports cognitive learning but also provides emotional and social engagement, encouraging collaboration among students during the learning process.

Genially is a highly effective platform for creating interactive and engaging learning experiences, thereby increasing student engagement [12]-[18]. Through Genially, educators can design a wide range of content types, including presentations, infographics, animations, videos, e-posters, curriculum vitae, quizzes, and gamification elements. Genially is available as a free or paid web-based application, allowing users to create interactive learning media, such as digital magazines or presentations, with various engaging features, including audio, video, animation, and games [1]. This platform features a simple and intuitive drag-and-drop interface, allowing users to design interactive and dynamic content with ease [19], [20]. Sabrina [21] states that Genially offers a free version with unlimited content creation access, as well as a paid version with additional features, including privacy controls, offline viewing, premium templates, folder grouping, and the ability to upload a personal logo. As a result, Genially enables teachers to design interactive lessons that cater to diverse learning styles, providing them with flexibility and creativity.

Studies by Sabrina [12] demonstrate that utilizing the TGT learning model with Genially media enhanced students' understanding of math concepts and increased their interest in learning. Rachmawati et al. [22] also found that combining Genially-based math materials with QuizWhizzer improved results in quadratic equations by as much as 90%. Additionally, Nurjanah et al. [14] created Genially-based history materials for SMAN 2 Woja, achieving an average effectiveness of 85%. This demonstrates that this type of media is effective in a classroom setting. These findings collectively reinforce the idea that Genially-based media can be applied across subjects and education levels, proving its versatility and adaptability in modern pedagogy.

Based on the problem description, the researcher is interested in implementing interactive learning media that have not been previously used in schools. This media is expected to assist teachers in delivering mathematics material while also helping students understand the concepts being taught. Therefore, this study is entitled: "The Effect of Using Genially Interactive Learning Media on Students' Understanding of Mathematical Concepts." This research aims to provide empirical evidence on the effectiveness of Genially-based learning in improving students' comprehension and to offer recommendations for future integration of digital media in mathematics education.

2. METHOD

This research was conducted at MAN 3 Medan, located on Jln. Pertahanan No. 99, Patumbak District, Deli Serdang Regency, North Sumatra, during the even semester of the 2025/2026 academic year. The research took place from July 18 to July 31, focusing on the topic of sequences and series. The sample consisted of two classes, selected randomly, with class X-7 serving as the experimental group and class X-8 as the control group. The selected sample represents a portion of the overall population that became the subject of this research [23].

Table 1. Research Sample

Class	Observations		Observations
	Male	Female	
X-7	18	16	34
X-8	17	17	34

This research employs a quasi-experimental approach. A quasi-experiment resembles a proper experimental design; however, it is more challenging to apply in real-world settings. Although it includes a control group, it cannot entirely control external variables that may affect the outcomes [24]. This design was considered the most suitable because random assignment at the individual level was not possible, given the existing class structure in schools. The design implemented in this study is the *Pre-Test and Post-Test Non-Equivalent Control Group Design*, where participants are divided into two groups: an experimental group that receives the treatment and a control group that does not [25]. The pre-test was conducted to determine the initial level of students' mathematical understanding, while the post-test was used to assess improvement after the intervention. The structure of this research design, as described by Silitonga [26], is presented in Table 2.

Table 2. Research Design

Experimental Class	$\boldsymbol{T_1}$	$\boldsymbol{X_1}$	$\boldsymbol{T_2}$	$\boldsymbol{A_1}$
Control Class	T_1	X_2	T_2	A_1

The study used tests and observations to collect data. The tests were made to check how Genially interactive media affects students' understanding of math. There were two types of tests: one administered before the study began (pre-test) and one administered after (post-test). Both tests were checked to make sure they worked well and gave consistent results. Observation sheets were also used to monitor student participation and engagement during the learning process, providing qualitative support for the quantitative test results. To analyze the data, they performed checks to determine if the data followed a normal distribution, if the groups were similar, and then they tested their main ideas or hypotheses. The data analysis process included normality testing, homogeneity testing, and hypothesis testing using the t-test at a 0.05 significance level to determine the effect of the treatment.

The research instrument used was a seven-item essay-based test of students' mathematical understanding. The following indicators of mathematical understanding were adapted from the standards of mathematical concept comprehension.

Table 3. Indicator of concept understanding

No	Indicators of Understanding Mathematical Concepts	Information	Skor
1	Restating a concept (containing known, asked, and answered)	Write 1 element	1
		Write 1 element	2
		Write 1 element	3
2	Classifying objects according to certain properties according to their concepts.	Writing a strategy, but it is incomplete	1
		Write down the strategy in full	2
3	Using, utilizing, and selecting certain procedures or operations (complete answer: proving a written plan)	Executing strategies with incomplete answers	1
		Implement strategies with complete answers	2
4	Applying concepts or algorithms to problem-solving	Writing 2 elements incorrectly	1
		Write 1 element correctly	2
		Write 2 elements correctly	3
	Skor		10

Before use, the instrument was piloted in different classes and schools. The pilot test was conducted at MAN I Deli Serdang from May 2 to 4, 2025, with 30 11th-grade students as respondents. The pilot test instrument was analyzed to identify and select valid and reliable instrument items. The pilot testing phase ensured that the items accurately and consistently measured students' conceptual understanding, aligning with the study's objectives.

Based on the validity test results below, there are seven valid questions and eight invalid questions. The valid questions are questions number 1, 2, 3, 6, 8, 9, and 15. The invalid questions are questions number 4, 5, 7, 10, 11, 12, 13, and 14. Therefore, for the next test, the researcher used seven valid questions that will be used at the research location. Each valid question item represented one or more indicators of conceptual understanding, ensuring that the instrument comprehensively covered the targeted learning outcomes.

Table 4. Results of Instrument Validity Test Calculation

No	r_{count}	r_{table}	Criteria
1	0,54851	0,361	Valid
2	0,53297	0,361	Valid
3	0,48566	0,361	Valid
4	0,32184	0,361	Invalid
5	0,03209	0,361	Invalid
6	0,75756	0,361	Valid
7	0,06789	0,361	Invalid
8	0,46865	0,361	Valid
9	0,42910	0,361	Valid
10	0,15204	0,361	Invalid
11	0,25262	0,361	Invalid
12	0,30610	0,361	Invalid
13	0,25262	0,361	Invalid
14	0,25262	0,361	Invalid
15	0,75756	0,361	Valid

After conducting the validity test, reliability test, discrimination test, and question difficulty test using the specified data criteria, the number of questions to be included in the next instrument can be presented in the following table. The results of these analyses demonstrated that the test items met the minimum statistical standards for research instruments, thereby confirming their feasibility for use in data collection.

Table 5. Question Items Used

No.	validity test	Reliability test	Difference Power Test	Difficulty Test
1	Valid	Reliable	Good	Medium
2	Valid	Reliable	Good	Medium
3	Valid	Reliable	Bad	Difficult
4	Valid	Reliable	Good	Difficult
5	Valid	Reliable	Bad	Difficult
6	Valid	Reliable	Bad	Difficult
7	Valid	Reliable	Good	Difficult

Overall, the method employed in this study systematically followed the stages of quantitative educational research, including determining the population and sample, selecting an appropriate design, developing and validating instruments, collecting data through structured procedures, and analyzing the data statistically to test the research hypothesis. This methodological structure ensures that the study produces reliable, valid, and generalizable findings regarding the effect of Genially-based interactive media on students' understanding of mathematical concepts.

3. RESULTS AND DISCUSSION

3.1 Results

A pre-test is a test given before the research starts. It helps find out what students know before they begin learning. After administering the pre-test, we received the first scores for the students' math results from two groups: the experimental group and the control group. The results from the pre-test are shown in Table 6. This stage was intended to identify the students' initial understanding level of mathematical concepts before any treatment was applied, ensuring that both groups started from comparable conditions.

Table 6. Pre-test Results of Experimental Class and Control Class

Statistics	Experimental Class	Control Class
Mean	62.0448	52.10084
Variance	117.481	86.49925
Standard Deviation	10.6783	9.300497
Maximum	81	76
Minimum	38	29
Observations	34	34

The pre-test results indicate that the average score of the experimental class (62.04) was slightly higher than that of the control class (52.10), suggesting a minor difference in initial comprehension. However, both averages were still below the school's minimum mastery criteria, indicating that the students' conceptual understanding before the intervention was generally low. This justified the need for implementing Genially-based interactive learning media as an instructional innovation.

After the treatment, participants took a final test, known as a posttest. This test helped in forming conclusions about the hypothesis. From the posttest results of both classes after the learning process, the average, spread, and standard deviation of students' understanding of math concepts were calculated. The comparison of posttest results between the experimental class and the control class is shown in Table 7. The post-test was designed to measure the improvement in students' conceptual understanding after receiving instruction, whether through Genially-based media or traditional methods.

Table 7. Post-test Results of Experimental Class and Control Class

Statistics	Experimental Class	Control Class
Mean	90.4412	64.4608
Variance	52.1143	73.9008
Standard Deviation	7.11207	8.5966
Maximum	100	79
Minimum	79	46
Observations	34	34

Based on Table 7, it can be observed that the experimental group achieved a substantially higher mean score (90.44) compared to the control group (64.46). This finding suggests that students who learned through Genially interactive media showed greater improvement and more consistent performance (as indicated by a lower standard deviation) than those who received conventional instruction.

The table below provides a summary of the normality test results for assessing how well students understood mathematical concepts in both the experimental and control classes. Normality testing is an essential prerequisite for determining whether the data meet the assumptions for parametric analysis, particularly when using t-tests.

Table 8. Results of Normality Test for Experimental Class and Control Class

Class	L_{count}		L_{table}		Criteria
	Experimental	Control	Experimental	Control	
Pre-test Experimental Class and Control Class	0.908393655	0.786894528	0.152	0.152	Normal
Post-test Experimental Class and Control Class	0.848444229	0.955465106	0.152	0.152	Normal

According to the testing criteria with significance values determined by the Lilliefors method (L_0), the pre-test significance value was 0.786894528 for the control class and 0.908393655 for the experimental class. Meanwhile, the post-test significance values were 0.848444229 for the experimental class and 0.955465106 for the control class. Since all significance values are greater than 0.05, H_0 is accepted and H_1 is rejected. Thus, the pre-test and post-test data on students' understanding of mathematical concepts in both the control and experimental classes are considered to be normally distributed. This result confirms that the distribution of scores meets the assumption of normality, allowing for the further use of parametric statistical tests.

The homogeneity test was conducted to determine whether the pre-test and post-test scores of students' mathematical concept understanding in the control and experimental classes originated from the same homogeneous population. For details, refer to Table 9. Testing homogeneity ensures that the variance between groups does not differ significantly, which is another requirement for applying the independent sample t-test.

Table 9. Results of the Pretest-Posttest Homogeneity Test of the Experimental and Control

Class	Variance		$\mathbf{F}_{count}$	$\mathbf{F}_{table}$	Criteria
	Experimental	Control			
Pre-test Experimental Class and Control Class	118.0159033	85.67532872	1.377478267	1.787821747	Homogeneous
Post-test Experimental Class and Control Class	50.85911669	69.67787115	1.370017328	1.787821747	Homogeneous

From table 9 above, it can be seen that the pre-test and post-test scores of students' mathematical concept understanding ability in the experimental and control classes. Based on the F test conducted, it was obtained $F_{count} < F_{tabel}$, so it can be said that the test data

of students' mathematical concept understanding ability is homogeneous. Hence, both classes possessed comparable variance, strengthening the validity of the subsequent hypothesis testing.

Based on hypothesis testing using a t-test, following the specified formula and criteria, the results of the hypothesis analysis, calculated using Microsoft Excel 2019 for Windows, are presented in Table 10. The t-test was applied to determine whether there was a statistically significant difference in the post-test means between the experimental and control groups.

Table 10. Results of Hypothesis Testing of Students' Mathematical Concept Understanding

	Post-Test Experimental Class	Post-Test Control Class
Mean	90.441176471	64.46078431
Variance	52.114280055	73.90077243
Observations	34	34
Pooled Variance	63.007526243	
Hypothesized Mean Difference	0	
df	66	
t Stat	13.495032922	
P(T<=t) one-tail	0.000000000	
t Critical one-tailed	1.668270514	
P(T<=t) two-tail	0.000000000	
t Critical two-tailed	1.996564419	

From the hypothesis testing at a significance level of $\alpha = 0{,}05$, based on the criteria for concluding, it was found that $1313.4950 > 1.99656$. Therefore, H_0 is rejected and H_1 is accepted. This indicates a significant difference between the post-test results of the experimental and control groups. This shows that the use of Genially interactive learning media has a significant effect on the mathematical concept understanding ability of grade X students at MAN 3 Medan. In other words, the integration of interactive digital tools successfully improved students' conceptual comprehension in mathematics compared to conventional learning methods, confirming the research hypothesis.

Overall, the statistical results—comprising normality tests, homogeneity tests, and t-tests—collectively demonstrate that Genially-based interactive learning media effectively enhance students' understanding of mathematical concepts. This improvement can be attributed to the media's interactive nature, which helps make abstract mathematical content more concrete and engaging.

3.2. Discussion

This research examines the impact of Genially interactive learning media on students' understanding of mathematical concepts. The study involved two sample groups, namely classes X-7 and X-8. Class X-7, comprising 34 students, was designated as the experimental group and received instruction using Genially interactive learning media, while Class X-8, also with 34 students, served as the control group and was taught through conventional

methods. Before the main study, a preliminary trial was conducted with class XI-1 at MAN 1 Deli Serdang. Once the data were collected, the researcher performed several analyses, including validity and reliability tests, as well as difficulty level and item discrimination tests for each question. This preliminary step ensured that the research instruments were both valid and reliable, thus strengthening the credibility of the data collected during the main study.

Before the treatment was administered, the initial level of students' understanding of mathematical concepts in classes X-7 and X-8 was analyzed through a pre-test. The results indicated that students' initial mathematical comprehension was relatively low. This finding is consistent with national and international reports such as TIMSS and PISA, which show that Indonesian students often struggle with abstract mathematical concepts and higher-order thinking skills. To enhance their understanding of mathematical concepts, the researcher implemented Genially interactive learning media in the experimental class, while the control class continued learning through a conventional approach. This approach aligns with constructivist learning theory, which emphasizes that students build knowledge more effectively when they actively engage with interactive and visual content rather than passively receive information.

After both classes received different instructional treatments using distinct learning media, a posttest was conducted to evaluate the improvement in students' understanding of mathematical concepts. The results revealed that the experimental class obtained an average score of 90, while the control class achieved an average of 64. These findings indicate that students in the experimental class, who were taught using Genially interactive learning media, showed a more significant enhancement in their comprehension of mathematical concepts compared to those in the control class who received conventional instruction. This substantial difference demonstrates that Genially can transform abstract mathematical material into interactive visual representations that help students comprehend relationships between concepts more effectively.

The application of Genially interactive learning media has proven effective in improving students' understanding of mathematical concepts. By transforming abstract material into more concrete and engaging forms, it enhances students' interest, collaboration, and active participation in the learning process. Learners who use Genially tend to be more actively involved in developing their skills compared to those who experience traditional teaching methods. This result aligns with previous studies by Sabrina [12] and Rachmawati et al. [13], which also found that Genially-based learning enhances student engagement and conceptual mastery in mathematics and other subjects. Moreover, the interactive elements in Genially—such as embedded videos, animations, and quizzes—stimulate visual and auditory learning, thereby accommodating different learning styles and promoting deeper cognitive processing.

Based on the F-test carried out using Microsoft Excel 2019 for Windows, H_0 was accepted and H_1 was rejected. Referring to the testing criteria with the significance value, it was found that $F_{hitung} < F_{tabel}$, indicating that the data from students' mathematical concept understanding tests are homogeneous. Furthermore, from the hypothesis testing at

the significance level of $\alpha = 0{,}05$, the result showed that $13.4950 > 1.99656$. Therefore, H_0 is rejected and H_1 is accepted, leading to the conclusion that the use of Genially interactive learning media has a significant effect on the mathematical concept understanding of grade X students at MAN 3 Medan. The statistical evidence strongly supports the effectiveness of Genially as an instructional innovation, confirming that the observed improvement in student learning outcomes is not due to chance.

4. CONCLUSION

Based on the findings and analysis, it can be concluded that the use of Genially interactive learning media significantly improves students' understanding of mathematical concepts among Grade X students at MAN 3 Medan. Students who learned through Genially achieved higher post-test scores compared to those taught with conventional methods, with a difference of 13.4950 > 1.99656, demonstrating the effectiveness of interactive digital media in enhancing conceptual comprehension. This result confirms that learning supported by Genially fosters a deeper understanding of abstract mathematical ideas by transforming them into engaging, visual, and interactive experiences.

The improvement observed in the experimental class also suggests that Genially catalyzes active learning, encouraging students to explore, visualize, and internalize mathematical concepts rather than merely memorize procedures. The interactive features embedded in the platform enable multi-sensory engagement, accommodating diverse learning styles and enhancing students' motivation.

This finding suggests that teachers should consider incorporating interactive learning platforms, such as Genially, into their classroom instruction to enhance student engagement, motivation, and understanding of abstract mathematical concepts. The integration of such technology not only enriches instructional strategies but also aligns with the current trend of digital transformation in education, where learners are expected to develop digital literacy alongside conceptual mastery.

However, the study was limited to a single school with a relatively small sample size, which may limit the generalizability of the results. Further limitations include the short duration of the intervention and the focus on a single mathematical topic (sequences and series), which may not fully represent students' performance across other mathematical domains. Therefore, caution should be exercised when extending these findings to broader educational contexts.

Future research is recommended to explore the use of Genially or similar interactive tools in different subjects and educational levels, as well as to examine their long-term effects on students' learning retention and problem-solving skills. Subsequent studies should also investigate teacher readiness, student attitudes, and the integration of Genially within blended or fully online learning environments. Through such expanded research, educators can gain a more comprehensive understanding of how interactive digital media can sustainably improve learning outcomes and foster innovation in classroom practices.

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