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The Effect of Using Genially on Eighth-Grade Students' Understanding of Mathematical Concepts in the Pythagorean Theorem

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ABSTRACT

This study aims to determine the effect of using Genially media on students' understanding of mathematical concepts in Pythagorean theorem material for eighth grade. This research is a quantitative study with a quasi-experimental method using a pretest-posttest control group design. The population was all eighth-grade students of SMP Negeri 2 Limboto. The sample was selected using random sampling technique, consisting of an experimental class of 25 students who learned using Genially media and a control class of 25 students who learned using PowerPoint media. The instrument used was an essay test consisting of 10 questions that had been validated and declared reliable with Cronbach's Alpha coefficient of 0.8751. The results showed that the average posttest score of the experimental class was 26.24, higher than the control class which was 21.56. Hypothesis testing using independent samples t-test obtained $t_{calculated} = 3.75$, while $t_{table} = 2.01$ at significance level $\alpha = 0.05$, so H_0 was rejected and H_1 was accepted. The effect size calculation using Cohen's d yielded a value of 1.06 which falls into the strong effect category. The conclusion of this study is that there is a strong effect of using Genially media on students' understanding of mathematical concepts in Pythagorean theorem material.

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INTRODUCTION

Mathematics is a discipline that plays a crucial role in developing logical, systematic, and analytical thinking skills. As a core subject in Indonesia, mathematics is taught progressively from elementary school through high school. Within the framework of the Merdeka Curriculum, mathematics instruction is not only focused on mastering procedures but also on developing conceptual understanding, logical reasoning, problem-solving skills, and mathematical dispositions (Kemdikbudristek, 2022). Among these various competencies, the understanding of mathematical concepts holds a fundamental position in mathematics learning.

Understanding mathematical concepts is not merely the ability to use formulas, but rather the ability to grasp their meaning, explain the relationships between concepts, and

represent them in various forms (Aleupah et al., 2023; Mahadi et al., 2023; Pauweni et al., 2019). In this study, mathematical conceptual understanding is understood as relational understanding according to Skemp (1978), namely students' ability to understand the reasoning behind a procedure and the connections between concepts. In the Pythagorean Theorem material, relational understanding is necessary because students not only use the formula $a^2 + b^2 = c^2$, but also understand the relationships between the sides of a right triangle that underlie the formation of that formula.

However, students' mastery of relational concepts remains a challenge in mathematics education. Several studies indicate that students still struggle to understand concepts, connect concepts, and solve problems that differ from the examples provided (Ibrahim et al., 2024; Irwanto et al., 2023; Kodai et al., 2024; Verina & Darhim, 2023). This situation was also confirmed by preliminary observations at SMP Negeri 2 Limboto on January 20, 2026, through interviews with mathematics teachers and a review of documents containing the results of the mathematics End of Semester Assessment (PAS) for the odd semester of the 2025/2026 academic year. Based on these data, out of 148 eighth-grade students, 143 students or approximately 96.6% had not yet met the school's Minimum Proficiency Criteria (KKM), which is set at 70. Interviews with teachers revealed that students were generally able to solve problems similar in format to the examples provided but struggled when problems were presented in different formats or required an explanation of the relationships between concepts. In the context of the Pythagorean Theorem, this indicates that students still tend to apply the formula procedurally and have not yet fully grasped the relationships between the sides of a right triangle.

Theoretically, learning that supports conceptual understanding requires media capable of bridging abstract concepts to more concrete forms. The use of learning media in mathematics is considered important because it can help present abstract concepts more clearly and support students' learning processes (Bito & Masaong, 2023; Hanifah et al., 2024; Muhaimin & Juandi, 2023). In addition, Halim & Hadi (2023) showed that digital media can support students' mathematical conceptual understanding. This aligns with the Cognitive Theory of Multimedia Learning proposed by Mayer (2022), which states that learning becomes more effective when information is presented through a combination of words and images.

One platform that aligns with the need for visual and multimedia-based learning media is Genially, a web-based platform that can be used to present learning materials in visual and multimedia formats (Zamzani & Raharjo, 2024). In this study, Genially incorporates multimedia elements such as text, images, visual illustrations, animations, and material displays. The interactive elements in Genially include menu navigation and

quizzes. Menu navigation is used to help move from one section of the material to another, while quizzes provide students with the opportunity to answer questions related to the material. With these characteristics, Genially is considered relevant for supporting the presentation of material on the Pythagorean Theorem, particularly in helping to clarify the relationship between the hypotenuse and the two legs of a right triangle.

Previous research has shown that Genially has a positive effect on students' understanding of mathematical concepts (Oktovianus, 2025; Sitorus & Karo-Karo, 2025). However, these studies have not specifically focused on the Pythagorean Theorem, and the measurement of conceptual understanding has not been based on relational understanding indicators according to Skemp. On the other hand, the study by Setiawan & Nuryadi (2024) shows that students' mathematical conceptual understanding of the Pythagorean Theorem is still relatively low. However, that study was descriptive in nature and therefore did not test the use of a specific learning medium as an intervention.

Given the limitations of previous studies, further research is still needed to directly examine the effect of using Genially on students' relational understanding of mathematical concepts in the context of the Pythagorean Theorem. The novelty of this study lies in its specific focus on examining the use of Genially in teaching the Pythagorean Theorem, as well as the use of Skemp's relational understanding indicators as a basis for measurement. This study is expected to provide empirical evidence regarding the effect of using Genially on students' mathematical conceptual understanding of the Pythagorean Theorem. Therefore, this study aims to determine the effect of using Genially on eighth-grade students' mathematical conceptual understanding of the Pythagorean Theorem. In line with this objective, the hypothesis of this study is that the use of Genially affects students' mathematical concept understanding of the Pythagorean Theorem.

METHOD

This study was conducted at SMP Negeri 2 Limboto during the 2025/2026 academic year. This study employed a quasi-experimental methodology with a quantitative approach to measure the effect of using the Genially platform on students' mathematical conceptual understanding of the Pythagorean Theorem. This method was chosen because the study was conducted in existing classes, making it impossible to randomly assign students to groups. The population in this study was all eighth-grade students at SMP Negeri 2 Limboto. The research sample was obtained through random sampling at the class level using a lottery system, resulting in the selection of two classes, each consisting of 25 students: one experimental class using the Genially platform and

one control class using PowerPoint. The research design employed was a pretest-posttest control group design, as presented in Table 1.

Table 1. Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X_1	O_2
Control	O_1	X_2	O_2

Notes:

O_1 : *Pretest* (initial assessment of mathematical concept understanding)

O_2 : *Posttest* (final assessment of mathematical concept understanding)

X_1 : Instruction using Genially

X_2 : Instruction using PowerPoint

The treatment was carried out during the learning of the Pythagorean Theorem. The learning activities were conducted for 6 lesson hours, divided into three meetings, with each meeting lasting 2 lesson hours or 80 minutes. The materials taught included the basic concept of the Pythagorean Theorem, Pythagorean triples, the converse of the Pythagorean Theorem, determining the type of triangle based on side lengths, and applying the Pythagorean Theorem to contextual problems.

In the experimental class, learning was conducted using Genially media, while in the control class, learning was conducted using PowerPoint media. During the learning process, students were directed to observe the presentation of the material, pay attention to the visual illustrations displayed, identify the relationship between the sides of a right triangle, discuss problems, work on student worksheets, answer questions, and draw conclusions about the concepts studied. The Genially media used in this study contained multimedia elements in the form of text, images, visual illustrations, animations, and material displays. Meanwhile, the interactive elements in the Genially media were found in the navigation menu and quizzes. The navigation menu was used to help students access certain parts of the media, such as competencies, materials, quizzes, instructions for use, and references, while the quizzes provided opportunities for students to respond to questions related to the material.

The instrument used in this study was an essay test on the Pythagorean Theorem, consisting of 10 items for both the pretest and posttest. The instrument was developed based on indicators of mathematical conceptual understanding referring to Skemp's relational understanding, namely students' ability to understand the reasoning behind a procedure and the connections between concepts. Therefore, each item was designed to measure the predetermined indicators of mathematical conceptual understanding. The distribution of the indicators used in the instrument is presented in Table 2.

Table 2. Distribution of Conceptual Understanding Indicators in the Instrument

Indicator of Mathematical Conceptual Understanding	Item Numbers	Number of Items
Restating concepts	1, 2	2
Classifying objects based on concept properties	3, 4	2
Providing examples and non-examples	5, 6	2
Representing concepts in various forms	7, 8	2
Applying concepts in problem solving	9, 10	2

Before being used as the research instrument, 12 essay items were tried out on 30 students. The empirical validity test was conducted at a significance level of 5% (0.05). Based on the analysis, 10 items were declared valid, while 2 items were invalid. The invalid items were not used in the pretest and posttest. The 10 valid items covered all planned indicators of mathematical conceptual understanding based on Skemp's relational understanding. Each indicator was represented by two items, so the instrument used in this study still represented the main variable, namely students' mathematical conceptual understanding of the Pythagorean Theorem. The reliability test yielded a Cronbach's Alpha coefficient of 0.8751, indicating that the instrument as a whole was reliable.

Hypothesis testing was conducted through inferential data analysis to determine the effect of using Genially on students' understanding of mathematical concepts. Data analysis was carried out through four stages of testing. First, a normality test was performed using the Liliefors test with the test statistic $L_0 = max|F(z_i) - S(z_i)|$, where $z_i = \frac{x_i - \bar{x}}{s}$. In this formula, $F(z_i)$ represents the cumulative probability of the standard normal distribution, while $S(z_i)$ represents the cumulative proportion of the empirical data. The data are considered to be normally distributed if $L_{calculated} < L_{table}$ at a significance level of 0.05.

Second, the homogeneity test was conducted using the F-test with the formula $F = \frac{Largest\ variance}{Smallest\ variance}$. The variances of the two groups were considered homogeneous if $F_{calculated} < F_{table}$ at the 0.05 significance level. The procedures for the Liliefors normality test and the F-test for homogeneity of variances were based on Sudjana (2005). Third, an independent samples t-test was used to determine differences in mathematical concept understanding between the experimental and control classes, with the criterion $t_{calculated} > t_{table}$ as the basis for rejecting H_0 and accepting H_1. Fourth, an effect size test using Cohen's d formula was conducted to determine the magnitude of the treatment's effect. The interpretation of the effect size followed Indrayati (2020), with the following

criteria: 0.00 – 0.20 (weak effect), 0.21-0.50 (moderately weak effect), 0.51-1.00 (moderate effect), and >1.00 (strong effect).

RESULTS AND DISCUSSION

Results

The research data were collected through pretests and posttests. The number of students who participated in the entire series of tests, from the pretest to the posttest, in each class was 25. Based on the pretest results, both classes obtained the same score of 10. This occurred because the scoring guidelines in this study assigned a minimum score of 1 to each item, including incorrect or unanswered responses. This finding indicates that there was no significant difference in initial ability between the two groups, so both groups were considered equivalent before the treatment was administered.

After the treatment was administered, a posttest was conducted to measure students' understanding of mathematical concepts. The frequency distribution of posttest scores in the experimental class that used the Genially platform is presented in Table 3.

Table 3. Frequency Distribution of the Posttest in the Experiment

Interval Class	f_i	$f_{relative}$
18 - 20	3	12%
21 - 23	4	16%
24 - 26	7	28%
27 - 29	5	20%
30 - 32	3	12%
33 - 35	3	12%
Total	**25**	**100%**

According to Table 3, 7 students (28%) scored below average, 7 students (28%) fell within the range that included the mean score, and 11 students (44%) scored above average in the experimental class.

The frequency distribution of posttest scores for the control class that used PowerPoint is presented in Table 4.

Table 4. Frequency Distribution of the Control Group's Posttest

Interval Class	f_i	$f_{relative}$
16 - 18	9	36%
19 - 21	5	20%
22 - 24	5	20%
25 - 27	3	12%
28 - 30	2	8%
31 - 33	1	4%
Total	**25**	**100%**

Table 4 shows that 14 students (56%) of the total number of students scored below average, 5 students (20%) fell within the interval containing the mean score, and 6 students (24%) scored above average in the control group. Before testing the hypotheses, preliminary tests were conducted, including tests of normality and homogeneity. A summary of the results of the preliminary tests is presented in Table 5.

Table 5. Results of the Normality and Homogeneity Tests for Posttest Data

Prerequisite Test	Experimental Class	Control Class	Criteria	Description
Normality ($L_{calculated}$)	0.112	0.160	$L_{table} = 0.173$	Normal
Homogeneity ($F_{calculated}$)	1.04		$F_{table} = 1.98$	Homogeneous

Based on Table 5, the normality test using the Liliefors criterion at a significance level of $\alpha = 0.05$ shows that $L_{calculated}$ for the experimental class is 0.112 and $L_{calculated}$ for the control class is 0.160. Both values are smaller than $L_{tabel} = 0.173$, so the posttest data for both classes are considered to be normally distributed. The homogeneity test using the F-test yielded $F_{calculated} = 1.04$, while $F_{table} = 1.98$. Since $F_{calculated} < F_{table}$, the variances of the two classes are declared homogeneous.

After the posttest data for the experimental and control groups were found to be normally distributed and homogeneous, a hypothesis test was conducted using an independent t-test. The results of the t-test are presented in Table 6.

Table 6. Results of the t-test

Test Statistics	Experimental	control
Sample Size	25	25
Mean	26.24	21.56
Variance	19.86	19.01
Degrees of freedom (df)	48	
$t_{calculated}$	3.75	
t_{table}	2.01	
Decision	H_0 rejected	

From Table 6, we obtain $t_{calculated} = 3.75$, while t_{table} at a significance level of $\alpha = 0.05$ with degrees of freedom df = 48 is 2.01. Since $t_{calculated} > t_{table}$, H_0 is rejected and H_1 is accepted. This means there is a significant difference in the mean mathematical concept comprehension scores between students who learned using Genially and those who learned using PowerPoint. The mean mathematical concept comprehension score for students in the experimental class ($\bar{x} = 26.24$) is higher than that of the control class ($\bar{x} = 21.56$).

Next, to determine the extent of the impact of using Genially on students' understanding of mathematical concepts, an effect size was calculated using Cohen's d formula. The calculation yielded a value of Cohen's d = 1.06. According to Cohen's classification of effect sizes, this value falls into the large effect category because d > 1.00.

Discussion

The results of the statistical analysis show that the average level of mathematical conceptual understanding among students in the experimental class differs significantly from that of the control class. The average posttest score for the experimental class was 26.24, which was higher than that of the control class at 21.56. This difference was confirmed through a t-test, with a calculated t-value $t_{calculated} = 3.75$ greater than the critical t-value $t_{table} = 2.01$ at a significance level of 0.05 and 48 degrees of freedom. Thus, H_0 was rejected and H_1 was accepted, indicating that the use of the Genially platform has a significant effect on students' understanding of mathematical concepts in the Pythagorean Theorem material. This effect is reinforced by a Cohen's d effect size of 1.06, which falls into the category of a strong effect.

This effect can be explained by the characteristics of the Genially platform used in instruction. In the Pythagorean Theorem unit, students are not only required to apply the formula $a^2 + b^2 = c^2$, but also to understand the relationship between the hypotenuse and the two legs of a right triangle. Through text, images, visual illustrations, animations, and a structured presentation of the material, Genially helps present these relationships between the sides in a more concrete way. The interactive elements in Genially are found in the menu navigation and quizzes. Menu navigation helps guide the presentation of the material from one section to another, while quizzes provide students with the opportunity to answer questions related to the concepts being studied.

The use of Genially also supports the development of relational conceptual understanding, as proposed by Skemp (1978) that is, an understanding that emphasizes not only the use of procedures but also the underlying reasoning. In learning the Pythagorean Theorem, visual aids help students see that the square of the hypotenuse is equal to the sum of the squares of the two legs. Thus, the Pythagorean concept is understood not merely as a computational procedure but as a meaningful mathematical relationship.

This finding aligns with Mayer (2022) Cognitive Theory of Multimedia Learning, which explains that learning becomes more effective when information is presented through a combination of text and images. In this study, Genially presented the material through text, images, visual illustrations, animations, menu navigation, and quizzes. This

presentation helped students connect verbal information with visual representations, thereby fostering a clearer understanding of the Pythagorean Theorem.

The results of this study are also consistent with the research by Sitorus & Karo-Karo (2025), which showed that Genially-based interactive media has a significant effect on students' understanding of mathematical concepts. These similar findings suggest that Genially can serve as a tool to support the understanding of mathematical concepts, particularly for topics that require visualization and connections between concepts. However, this study makes a unique contribution because it focuses on the Pythagorean Theorem and measures conceptual understanding based on Skemp's relational understanding framework.

The differences in characteristics between Genially and PowerPoint are one of the reasons for the differences in students' mastery of mathematical concepts. In the control class, PowerPoint was used as a medium for presenting material in a more sequential manner, whereas Genially supports the presentation of material through visual displays, animations, menu navigation, and quizzes. Nevertheless, this study has limitations because it was conducted at only one school, focused on a single dependent variable, and Genially's interactive features were not utilized throughout the entire presentation. Therefore, future research could design the use of Genially to allow for broader exploration and test its impact on different learning materials or variables.

CONCLUSION

Based on the research findings and discussion, it can be concluded that the use of Genially-based learning media has a significant effect on students' understanding of mathematical concepts related to the Pythagorean Theorem. This is indicated by the t-value $t_{calculated} = 3.75 > t_{table} = 2.01$, the higher average posttest score of the experimental class compared to the control class, and a Cohen's d effect size of 1.06, which falls into the strong effect category. In terms of relational understanding as defined by Skemp, Genially helps present the relationship between the hypotenuse and the two legs in a more visual and structured manner. Therefore, Genially can be used as an alternative mathematics learning medium, particularly for topics that require visual representation. Future research is recommended to examine the use of Genially in other mathematics topics, with different variables, or with a broader sample size.

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