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Pythagorean Calc Aplication: Is It Effective in Mathematical Understanding Ability?

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Abstract

Understanding mathematics requires deep thinking to learn it meaningfully. However, empirically, many students face complex difficulties in understanding mathematical concepts. This study aimed to determine the quality of improvement before and after using the Pythagorean Calculator application and to find out the effectiveness of using the Calc application on the student's ability to understand mathematics. This research uses a quantitative approach with a quasi-experimental method. This study was conducted at one of the private MTs in Ciamis district, West Java, by taking samples using purposive sampling, namely Class VIII B in the 2023/2024 academic year with a total of 21 students. Data was collected through a high-level mathematical understanding ability test based on the Polya indicator. The results of the research show that the quality of improvement in mathematical understanding abilities after learning assisted by the Pythagorean Calc application on the Pythagorean theorem material with the level of difference is in the medium category. Using the Pythagorean Calc application is effective in improving mathematical understanding abilities and is classified as a strong effect category.

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INTRODUCTION

In mathematics learning situations, there are two main challenges, namely developing understanding and stimulating level thinking skills (Zhang, 2019). The development of comprehension abilities is influenced by the involvement of students' higher-order thinking during the learning process (Ferrer et al., 2022). Therefore, the ability to understand mathematics is crucial to achieving optimal learning success (Pebrianti & Puspitasari, 2023). Learning methods that focus on memorizing concepts and achieving material objectives succeed in the context of short-term competence. However, this method is often ineffective in improving understanding, identification and application of ideas, thus hindering the development of students' thinking skills to solve problems in long-term life (Susilawati et al., 2019).

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The ability to understand mathematics is very important to achieve successful mathematics learning (Johnson et al., 2019). Mathematical understanding is not only crucial in an academic context but also makes a significant contribution to the development of cognitive skills (Lowrie et al., 2020). Comprehension ability is a foundation for problem-solving that shows students' mastery of mathematical concepts and skills (Sunismi & Setiawan, 2022). The success of mathematics learning can be seen through students' ability to understand and solve various mathematical problems. This becomes a practical test of students' ability to apply mathematical concepts in everyday life. A deep understanding of mathematics allows students to apply mathematical concepts more flexibly in a variety of situations. Understanding mathematics depends not only on the ability to write formulas or memorize concepts but also on the extent to which students can effectively apply their knowledge to solve problems (Utami & Hwang, 2021). The indicators of students' high-level mathematical comprehension ability based on Polya are proving the correctness of formulas and theorem and estimating the truth with certainty before analyzing further(Anisa et al., 2021). Therefore, a deep understanding allows students to apply mathematical concepts flexibly in a variety of situations. Success in learning mathematics can be observed through the student's ability to understand and solve math problems. It is important for math teacher to give sufficient attention to the development of students' mathematic understanding.

Based on empirical experience from initial observations at a private MTS school in Ciamis Regency, West Java, several students face difficulties in solving problems based on mathematical understanding of two-variable linear equation system materials such as difficulty using formulas or effective methods in solving problems and applying structured or sequential problem-solving approaches, making it difficult to analyze further. In addition, students have not been able to perform algorithmic calculations associate problems with variables, and prove the validity of formulas or methods as also revealed (Prayekti, 2019). Students are also mistaken in constructing and translating mathematical sentences into symbols and images, as described by (Rashidov, 2020).

In some cases, students also have difficulty understanding problems based on mathematical understanding which results in difficulty solving mathematical problems and breaking complex mathematical information into simple ones (Wati et al., 2022). In line with (Agustini & Pujiastuti, 2020) often students do not build their understanding of mathematical concepts, preferring to memorize these concepts without understanding their meaning. Therefore, students often make mistakes and have difficulty in finding solutions to mathematical understanding problems. Students also have limitations in understanding the structure of the problem, so it is difficult to formulate the right method for solving problems based on mathematical understanding. This is also made clear (Meutia, 2020) that students' involvement in knowledge construction is still limited, often they only receive information passively from the teacher. As a result, they face difficulties in overcoming problems that differ from the examples presented by the teacher and only apply the examples and complete the exercises according to the patterns taught, without being based on understanding the concepts. In addition, some students often make mistakes in formulating and reflecting on solution ideas such

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as research (Natalliasari et al., 2023). Another difficulty in the proof process is due to forgetting the proof formula. It is appropriate (Hidayat & Pujiastuti, 2019) that students write down proofs without going through the right steps because they forget the formula. Some students also often make mistakes in running algorithms to solve non-routine problems that require high thinking (Cason et al., 2019). The learning outcomes of these students tend to be not optimal because the use of learning models and media provided by teachers is less attractive (Mulyati & Evendi, 2020).

Some previous researchers used learning media, especially in delivering Phytagoras material at the junior high school level. These researchers include (Sunaryo & Bernard, 2022); (Alkhateeb & Al-Duwairi, 2019), and (Syafitri, 2023). The media used include *App Inventor*, *Geogebra*, and *Sketchpad*. These media are proven to improve students' mathematical cognitive abilities. Current technological developments cause many variations of learning media that can be utilized by educators to help students better understand the material being studied. One of these learning media is *Pythagorean Calc*. The use of the Pythagorean Calc application *has the potential to improve mathematical comprehension skills, especially in* Pythagorean material. The *Pythagorean Calc* application can be accessed through Android devices and provides assistance to teachers and students in solving problems related to the Pythagorean theorem and helps find solutions related to the sides and angles of right triangles (Ruhma, 2022). The use of applications on mobile devices is seen as more satisfying needs and is considered more effective in its implementation (Irawan et al., 2022).

Based on several articles that have been described, it can be seen that there have not been many specific studies that delve deeply into the effectiveness of using the Pythagorean Calc application as a step to improve mathematical understanding on the topic *of the Pythagorean* Theorem. In addition, the Pythagorean Calc application is not much used by teachers or other researchers in mathematics learning, so it is necessary to carry out in-depth research to provide reference to the world of mathematical education on the use of the android application as one of the learning media. Thus, referring to the context described earlier, the aim of this research is to find out the effectiveness of using the pythagorian calc application in optimizing the ability to understand maths. Thus, referring to the context previously described, the purpose of this study is to focus on the use of *Pythagorean Calc* applications in optimizing mathematical understanding abilities. The effectiveness of this application will be determined later. The significance of this research lies in its potential contribution to provide deep insight into efforts to improve mathematical understanding. Thus, it is hoped that the results of this study can provide valuable guidance and reference for educators that allow them to improve teaching methods by integrating technology on the Android *platform* to overcome potential difficulties that students may face in dealing with mathematical problems, especially those related to the material of the Pythagorean theorem.

RESEARCH METHOD

The research used a quantitative approach with a quasi-experimental method. The purpose of this study focuses on the use of *Pythagorean Calc*

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applications in optimizing mathematical understanding abilities on Pythagorean theorem material. The study population included the entire class VIII in one of the private MTs in Ciamis Regency, West Java totaling 42 students divided into 21 students in class VIII A and 21 students of class VIII B. Sample determination is done through purposive sampling, by selecting students from grade VIII B because the class has a homogeneous level of initial ability and has adequate access to technology. Class VIII B as many as 21 students as an experimental class with *treatment* using learning assisted by the *application of Pythagorean Calc on the Pythagorean* theorem material. The research design is *a one-group pretest-posttest design*. This research used *a pretest* before treatment, then learned Pythagorean theorem material with *the Pythagorean Calc* application, and then a posttest. The mathematical comprehension ability of students after treatment is compared with the mathematical comprehension ability of students before being given treatment.

The data collection technique uses a high-level mathematical comprehension ability test instrument based on the Polya indicator that has been validated and has a high-reliability value. The data were analyzed with descriptive statistics assisted by SPSS Version 20, then used *Normalize Gain* (*N-gain*) value analysis to measure the increase in mathematical understanding skills between before and after learning assisted by *the Pythagorean Calc* application and the quality of the improvements, then analyzed with *effect size* to determine the effectiveness of the learning model. The *N-gain value* is calculated with the help of *Microsoft Excel* with the following formula (Rosyita & Tsurayya, 2021) :

$$N - gain = \frac{Skor\ posttest - skor\ pretest}{Skor\ maksimal - skor\ pretest}$$

The interpretation of normalized gain categories can be seen in table 1 (Rosyita & Tsurayya, 2021).

Table 1. Gain Index Criteria

Value	Category
$IG \leq 0{,}30$	Low
$0{,}30 < IG < 0{,}70$	Keep
$IG > 0{,}70$	Tall

Furthermore, for *single groups*, using *the effect size* test with *Cohen's* formula (Pratama et al., 2022) as follows:

$$ES = \frac{mean\ of\ posttest - mean\ of\ pretest}{standard\ deviation\ of\ pretest}$$

The results of the *effect size* calculation were interpreted using the classification of Cohen, Manion, and Marrison in 2007 (Panie et al., 2023) presented in the following table:

Table 2. Effect *Size Classification*

Magnitude *of Effect Size* (ES)	Interpretation
$0 - 0.20$	*Weak effect*
$0.21 - 0.50$	*Modest effect*

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Magnitude *of Effect Size* (ES)	Interpretation
$0.51 - 1.00$	*Moderate effect*
> 1.00	*Strong effect*

RESULTS AND DISCUSSION

To analyze the effectiveness of the *Pythagorean Calc application* in optimizing students' mathematical understanding ability of Pythagorean theorem material, several analyses were carried out including descriptive statistical analysis, *normalized gain*, and *effect size*. From the results of the mathematical comprehension ability test, information was obtained about data from research related to the mathematical comprehension ability of MTs students and processed descriptively statistically seen from the highest score, lowest score, standard deviation, average *value (mean*), middle value (median*), and most value (*mode*) which can be accessed through the following table 3.*

Table 3. Description of Mathematical Comprehension Abilities

	N	*Min*	*Max*	*Sum*	*Mean*		*Std. Dev*	*Variance*
	Statistics	Statistics	Statistics	Statistics	Statistics	Std. Error	Statistics	Statistics
Pre-test	21	25	83	1166	55.52	3.912	17.927	321.362
Post-test	21	33	100	1618	77.05	5.489	25.154	632.748
Valid *N* (listwise)	21							

Maximum Score: 100

The variable data of mathematical comprehension ability in table 3, shows that for the value of mathematical comprehension ability at the time *of the pre-test, the average score of the initial students was 55.52% and the post-test* average was 77.05%. There was an increase of 21.53%. In percentage terms, this increase is quite significant but will be checked further using *the N-gain* and *effect size test*.

The data is then analyzed using Microsoft Excel-assisted N-gain calculations. The *N-gain* value is used to measure the improvement in mathematical comprehension skills between before and after *Pythagorean Calc* application-assisted learning. Here are the results of *the N-gain* calculation in table 4.

Table 4. *N-gain Value Analysis*

No.	Subject	*Pre-test*	*Post-test*	*N-gain*
1	S1	67	100	1
2	S2	67	100	1
3	S3	50	67	0.34
4	S4	25	42	0.2266667
5	S5	58	83	0.5952381
6	S6	42	92	0.862069
7	S7	33	33	0
8	S8	50	100	1

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No.	Subject	*Pre-test*	*Post-test*	*N-gain*
9	S9	33	33	0
10	S10	83	100	1
11	S11	75	100	1
12	S12	83	92	0.5294118
13	S13	50	92	0.84
14	S14	25	42	0.2266667
15	S15	67	58	-0.2727273
16	S16	58	100	1
17	S17	58	92	0.8095238
18	S18	50	100	1
19	S19	75	75	0
20	S20	42	42	0
21	S21	75	75	0
	Average	55.52	77.05	0,531

Based on the results of the calculation of the *N-gain value, a* score of 0.531 was obtained which was classified as a medium category, which means that the quality of increasing students' mathematical understanding before and after using *Pythagorean Calc* was in the medium category. This category is because students are quite helped by the application *of Pythagorean Calc while studying the material of the Pythagorean* Theorem. Furthermore, to see the effectiveness of using *the Pythagorean Calc application,* followed by an *effect size* test as shown below:

$$ES = \frac{mean\ of\ posttest - mean\ of\ pretest}{standard\ deviation\ of\ pretest}$$

$$ES = \frac{77.04 - 55.52}{17.92}$$

$$ES = 1.20$$

Because it can be classified as $ES = 1{,}2 > 1.00$ *strong effect.* This means that the effectiveness of the *Pythagorean Calc application learning media* is classified as a strong or strong *effect*. From the results of data analysis, information was obtained that the use of the *Pythagorean Calc application* was effective in improving students' mathematical understanding abilities.

The quality results of increasing students' mathematical understanding ability after getting learning assisted by the *Pythagorean Calc* application are in the medium category with effectiveness being at a *strong effect*. These results indicate that the application *of Pythagorean Calc is quite effective if given to students, especially on the material of the Pythagorean* theorem. This is in line with research (Soleha & Mariani, 2023) that there is a relationship between learning outcomes before treatment and after learning treatment with Pythagorean theorem learning media. The results of the analysis showed that the correlation of 0.753 was in the medium category. In the *Pythagorean Calc app*, students can automatically calculate the length of the sides of a right triangle when the two sides of the triangle are known. Furthermore, this application can also perform automatic calculations

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for the length of the side of a right triangle if two angles and one side of the triangle are known. This will provide convenience for students and teachers in solving mathematical problems related to the Pythagorean theorem. As revealed (Ruhma, 2022), th*e Pythagorean Calc* application can be downloaded at no cost through the Android platform with a relatively small file size, around 10.68 mb. The app doesn't require an internet connection to perform automatic calculations. In addition, *Pythagorean Calc is designed with an easy-to-use interface, making it practical for students and teachers to perform calculations of the Pythagorean theorem.*

The use of learning media in this case *Pythagorean Calc* proved effective in improving mathematical comprehension skills. Several previous researchers also suggested the positive impact of using learning media on increasing student understanding in learning the Pythagorean theorem (Putra et al., 2020). The results reveal that the use of learning media in learning the Pythagorean theorem can facilitate students in understanding Pythagorean concepts. Several students who initially had difficulty understanding Pythagorean concepts showed progress after using the medium, increasing their understanding of mathematical concepts. In addition, the use of learning media is also proven to encourage student learning motivation, where all students show high enthusiasm in the learning process. Students who attended Pythagorean learning classes showed no reluctance to complete the assigned tasks. In fact, many students were able to solve Pythagorean problems with their creativity and version of the approach.

Other studies by (Reswari et al., 2021); (Kania & Arifin, 2020) indicate that the use of technology-based learning media is considered more effective when compared to conventional learning media. Therefore, teachers must present technology-based learning, both on Pythagorean material and on other materials, to achieve learning objectives as expected. The *Pythagorean Calc* application also acts as a tool or medium that can improve students' mathematical understanding abilities in experimental classes. This is because it can help students solve mathematical understanding problems on Pythagorean material. In accordance with (Mashuri, 2019), learning media functions as a communication tool to streamline the learning process and clarify messages in teaching and learning activities as an effort to innovate in education so that learning achieves its goals and can improve students' mathematical understanding abilities. Some of the other advantages of Pythagoras calculator media in learning is that it can help students in understanding complex mathematical concepts, such as in calculating the length of triangle sides using Pythagos formula. This medium can make it easier for students to perform calculations, thus accelerating the learning process and minimizing manual calculation errors as well as improving student motivation and activity in learning (Irawan et al., 2022).

CONCLUSION

Based on the results of the analysis, it was concluded that there was a difference in increasing mathematical comprehension skills between before and after learning assisted by the Pythagorean Calc application on the *Pythagorean theorem* material in Class VIII B, one of the private MTs in Ciamis Regency with the quality of improvement in the medium category. Then, the use of *the*

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Pythagorean Calc application is also effective in improving mathematical understanding skills and is classified as a *strong or strong effect* category.

With this research, it is hoped that teachers can consider the integration of *Pythagorean Calc* applications in mathematics learning, especially in Pythagorean material, so that students can be more familiar with technology and its application can be more continuous, and students' mathematical understanding skills can increase.

The findings may also lay the groundwork for future research that investigates similar aspects by including experimental and control groups. In addition, further research can be carried out in the realm of thinking skills that vary and are reviewed by gender or student learning styles.

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