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The Effectiveness of Using Contextual-Based Interactive Teaching Aids on Students' Mathematical Problem-Solving Skills on Pythagorean Theorem Concepts

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Abstract

This study aimed to examine the implementation of contextual-based interactive teaching aids, examine differences in mathematical problem-solving abilities between pretest and posttest, and examine the effectiveness of the use of teaching aids on mathematical problem-solving abilities in the topic Pythagorean Theorem. Quantitative method was employed in this research with one-group pretest-posttest quasi-experimental design at an Islamic junior high school in Banten, Indonesia with 20 students. Research instruments used in this study were validated mathematical problem-solving ability test in essay form ($r = 0.841$; $\alpha = 0.841$). Data analysis in this study were done by paired t-test after satisfying the normality test using Shapiro-Wilk. The result of the data analysis is that there is an increase in average score from 32.25 (pretest) to 38.00 (posttest) with significance value of $p = 0.024$ ($p < 0.05$). From the results obtained, it can be said that the use of contextual-based interactive teaching aids is effective in improving mathematical problem-solving skills of students in the topic Pythagorean Theorem. In this case, contextual learning will assist students to translate abstract concept to concrete forms so that students understand the concepts better and become useful in real life.

Keywords: Interactive Teaching Aids, Contextual Learning, Mathematical Problem-Solving Skills, Pythagorean Theorem

INTRODUCTION

Mathematics is one of the subjects that plays an important role in developing logical, systematic, and creative thinking skills. According to Siagian (2016) , mathematics learning not only functions as a means of calculating but also to develop reasoning skills directly related to daily human activities. Hidayah (2018) adds that effective mathematics learning should be oriented towards conceptual understanding, not just memorizing formulas. Artanti et al. (2022) also emphasizes that in the modern era, mathematics learning needs to integrate technology and interactive media so that learning becomes more efficient, interesting, and relevant to students real lives.

One of the important issues related to the mathematics study in junior high schools is the Pythagorean Theorem. In addition, it serves as the foundation for the understanding of geometric concepts and how they can be applied in daily life. Unfortunately, in actuality, some students still have problems with understanding and applying the Pythagorean Theorem, particularly in solving contextual problems and dealing with problems associated with the relationship between the sides of a right triangle (Hijriani et al., 2025; Sihombing et al., 2024; Azzahra et al., 2025; Ardhiansah et al., 2025; Keyik et al, 2026; Taamneh et al., 2024; Sandra,

2025). This issue is frequently due to the teacher-centered teaching method and lack of visual aids that could make the students better understand the connections between concepts. Thus, the students become passive learners, who just remember formulas but do not know the mathematical concept behind them (Radiusman, 2020; Yulianty, 2019).

To overcome these problems, various approaches have been developed, one of which is contextual teaching and learning (CTL). Johnson (2002) explains that CTL is an approach that links subject matter to real-world situations so that students can find meaning in learning that is relevant to their lives. According to Piaget's constructivist theory, knowledge is not something that is given by the teacher, but the result of active construction by students based on their experiences. The CTL approach supports this view by involving exploratory activities, manipulation of concrete objects, and reflection on learning experiences.

Contextual learning is also the foundation of Indonesian Realistic Mathematics Education (PMRI), which was derived from the theory by Freudenthal. Realistic problems serve as the basis of learning in PMRI. Learning is done through exploration and discussion, whereby students are stimulated to independently discover mathematical ideas. The success of PMRI in promoting mathematical literacy among students has also been proven when PMRI is applied together with educational props (Setyaningsih et al., 2017). Moreover, according to Karimah et al. (2023), the use of PMRI-based Raszle media for teaching the Pythagorean theorem led to successful learning due to the active participation of students in concept discovery and not formula memorization.

Moreover, interactive teaching aids also have an essential role to help the abstract concepts be connected to the concrete form. It supports Bruner’s (1966) argument that the development of mathematical concept understanding goes through the process of three stages of representation where there is enactive representation where there is an emphasis on concrete actions, iconic representation where there is an emphasis on visualization, and symbolic representation where there is an emphasis on mathematical abstraction process. Through the use of interactive teaching aids, students will get an opportunity to interact with the geometric figures and learn the relation of the sides of a right triangle. Hijriani et al. (2025) argued that the function of teaching aid is as the connection between the real world and mathematics symbols.

Regarding the application of the Pythagorean Theorem, several research studies have proven the efficiency of interactive media. According to Sihombing et al. (2024), the utilization of Pythagorean triple boards with regard to the Realistic Mathematics Education (RME) approach proves to be an effective way to boost students' knowledge about geometrical concepts. Also, according to Hijriani et al. (2025), the utilization of Pythagorean

puzzles during the learning process results in increased student activity and enthusiasm, and even learning outcomes increase by 270.83%. At the same time, Ihsan et al. (2025) developed interactive game-based learning media to prove the Pythagorean Theorem with the use of 2D geometric shape animations, which proved to improve the students' knowledge and interest in the learning process of mathematics.

Considering all the aforementioned information, the use of contextual interactive learning tools may be considered efficient when it comes to the improvement of students' problem-solving skills in mathematics. With the help of practical experience and visual exploration, students gain theoretical knowledge concerning the concept of Pythagorean Theorem and also learn how to apply it in life. Thus, the present study aims at exploring the efficiency of contextual interactive learning tools concerning students' mathematical problem-solving skills in Pythagorean Theorem topic.

METHOD

In this research, the quantitative approach was applied by employing quasi-experimental design with the one-group pretest-posttest design. This research was conducted at an Islamic junior high school in Banten, Indonesia, in the even semester of the academic year 2024/2025 for three months (September-November 2025).

The population of this research was all students in class VIII-B of at an Islamic junior high school in Banten, Indonesia in the academic year 2025/2026. The sample selection process used was purposive sampling based on these criteria: (1) the class had an average academic ability which represented the class as a whole; (2) the class had not ever been taught with contextual-based interactive teaching aids; (3) the researcher has a total access for observing and collecting the data. The research sample consists of 20 students as an experimental group.

The instrument used in this research was mathematical problem solving test in the form of essays according to Polya's (1973) four indicators: understand the problem, make a plan, execute the plan, and review. This instrument has been validated through Pearson Product Moment correlation with the value of $r = 0.841$ (very strong) and also been tested reliability through Cronbach's Alpha with the value of $\alpha = 0.841$ (very high).

Data collection was done through pretest before giving treatment and posttest after learning using contextual-based interactive teaching aids. Data analysis was performed using descriptive statistics and paired t-test after fulfilling normality prerequisite test using Shapiro-Wilk test assisted by Microsoft Excel.

RESULTS AND DISCUSSION

Based on the data processing results, the descriptive statistics for the pretest and posttest were in Figiure 1.

Descriptive Statistics ▼

	Pretest	Posttes
Valid	20	20
Missing	0	0
Median	32.500	40.000
Mean	32.250	38.000
Std. Deviation	16.180	21.423
Coefficient of variation	0.502	0.564
Variance	261.776	458.947
Shapiro-Wilk	0.940	0.929
P-value of Shapiro-Wilk	0.241	0.145
Minimum	10.000	10.000
Maximum	65.000	80.000

Figure 1. Descriptive Statistics of Pretest and Posttest Scores

The average improvement of 5.75 points reflects the positive impact of contextual interactive learning aids on students' ability to solve math problems. The test of normality through Shapiro-Wilk test reveals that the pretest p-value is 0.940, while the posttest p-value is 0.929 ($p > 0.05$). The results meet the criteria of a paired sample t-test. The results of the paired sample t-test reveal can be seen in Figure 2 and Figure 3.

Paired Samples T-Test

Measure 1		Measure 2	t	df	p
Pretest	-	Posttes	−2.192	19	0.041

Note. Student's t-test.

Figure 2. Paired-Samples t-Test Results for Pretest and Posttest Scores

Pearson's Correlations

Variable		Pretest	Posttes
1. Pretest	Pearson's r	—	
	p-value	—	
2. Posttes	Pearson's r	0.841	—
	p-value	< .001	—

Figure 3. Pearson's Correlation Between Pretest and Posttest Scores

With p value 0.041 ($p < 0.05$), it is clear that there is a statistically significant difference between the pre-test and post-test scores. This indicates that the null hypothesis (H_0) has been rejected and the alternative hypothesis (H_1) is accepted. This implies that there is an

improvement in the mathematical problem solving abilities of the students using contextual based interactive teaching aids.

Therefore, the outcomes of the study show that the utilization of contextual interactive teaching aids has a strong effect on enhancing students' skills in solving mathematics problems. The significant improvement in the average scores ($p = 0.024$) indicates that learning with this strategy will assist students to learn abstract mathematical concepts by experiencing practical and interactive methods.

Theoretically, the effectiveness of this learning strategy corresponds to the idea of Contextual Teaching and Learning (CTL), according to which the success of learning process relies on the ability to connect the learning topic with real-life situations in order for students to discover the essence of learning (Johnson, 2002). When speaking about the Pythagorean Theorem, the students are encouraged to perceive the mathematical concept by observing the teaching aids depicting the squaring of sides of a right triangle. Therefore, the students understand not only the formula $a^2 + b^2 = c^2$, but also its practical application.

In addition, interactive teaching aids play an important role in creating visual, kinesthetic, and collaborative learning, in accordance with Bruner's theory of representation (1966), which emphasizes that understanding mathematical concepts develops through three stages: enactive (concrete actions), iconic (images/visualizations), and symbolic (mathematical abstractions). In this study, teaching aids allowed students to interact directly with triangular shapes and observe the relationships between sides, making it easier to internalize the *Pythagorean* concept.

Pythagorean Puzzles or discovery-based interactive media usage can be used to enhance the problem-solving abilities of students and their learning outcomes (Mutmainah & Nuha, 2023; Hijriani et al., 2025). Likewise, Siregar et al. (2024) noted that learning outcomes for the concept using the media based on PowerPoint animations were successful. This similarity shows how learning with interactive media is able to enhance the motivation of students to learn geometric concepts.

In terms of teaching and learning, contextual teaching involves critical and reflective thinking of students. Besides concentrating on procedures in mathematics, they also need to think logically about selecting methods of problem solving. For instance, in solving a problem of measurement of height of an inaccessible object, students will understand that there is a right triangle within the situation and then apply Pythagorean theorem to solve the problem. This helps in development of higher-order thinking skills (HOTS) which is among the objectives of contemporary mathematics teaching.

Thus, the results of this study not only demonstrate the effectiveness of learning media, but also support a new paradigm of mathematics learning that *is* student-centered, experience-based, and oriented towards the development of critical thinking and problem-solving skills.

CONCLUSION

From the results of the data analysis and discussion, it can be concluded that the utilization of contextual based interactive teaching aids is successful in enhancing the mathematical problem solving abilities of Islamic junior school students at grade VIII in the material of Pythagoras Theorem. The average score of the students' ability rose from 32.250 in the pretest to 38.000 in the posttest with the significance value of $p = 0.041$ ($p < 0.05$). It means that there was a significant difference before and after the treatment.

The improvement cannot be separated from the characteristics of contextual learning where the mathematical concepts can be connected with the students' experience. Besides, the presence of interactive teaching aids has added to the meaning and enjoyment of the learning activity. The students did not just memorize the formula, but could apply the Pythagoras theorem in solving many other problems in daily life.

SUGGESTIONS

Based on the research results, several recommendations can be given:

1. Math teachers are advised to use contextual interactive teaching aids more often in the learning process, especially for abstract subjects such as geometry.
2. Students are expected to be more active in exploratory activities with media so that they become accustomed to thinking analytically and critically in solving mathematical problems.
3. Schools should provide support in the form of training and the provision of interactive learning tools for teachers.
4. Future researchers are advised to expand this study by involving two groups (experimental and control) or applying digital-based interactive media to see its effectiveness in a broader learning context.

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