

THE EFFECT OF GEOMETRY CONCRETE LEARNING MEDIA ON STUDENTS' MATHEMATICS LEARNING OUTCOMES

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ABSTRACT

Mathematics is often perceived as a difficult subject because many of its concepts are abstract and difficult for students to visualize. The use of appropriate learning media is therefore essential to support students' conceptual understanding, particularly in geometry topics such as plane figures. This study aims to investigate the effect of concrete object learning media on the mathematics learning outcomes of Grade VII students at SMPN 2 Suwawa. This research employed a quasi-experimental method using a Pretest-Posttest Control Group Design. The sample consisted of 36 students selected through simple random sampling and divided into an experimental group and a control group. The experimental group was taught using the Contextual Teaching and Learning (CTL) model supported by concrete object media, while the control group received CTL instruction without concrete media. Data were collected using pretests and post-tests in the form of essay questions to measure students' cognitive understanding of plane geometry. Instrument validity and reliability were tested prior to data analysis, which included descriptive statistics and inferential tests such as normality, homogeneity, and independent t-tests. The results show that students in the experimental group achieved significantly higher post-test scores (mean = 88.27) than those in the control group (mean = 64.50). The hypothesis testing revealed a calculated t-value of 6.1028, exceeding the critical t-value of 1.691, with a very strong effect size (Cohen's $d = 2.1985$). In conclusion, the use of concrete object media within the CTL model significantly improves students' mathematics learning outcomes. This approach is effective in creating meaningful and active learning experiences, particularly for abstract mathematical topics such as plane figures.

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INTRODUCTION

Mathematics holds a central role in the education system because it provides foundational skills necessary for logical reasoning, problem-solving, and intellectual development across all levels of schooling (Fajriyah, 2018; Yudha, 2019). From early childhood, students are introduced to

basic numerical concepts that prepare them to face increasingly complex mathematical ideas in higher grades (Mytra et al., 2023). Through mathematics learning, students are expected to develop creative and flexible thinking, as well as problem-solving abilities that are essential for academic success and daily life (Hayati & Jannah, 2024).

Every student needs mathematics to develop practical and critical thinking skills in order to solve problems and understand other fields of study, including economics, accounting, physics, and others (Arham et al., 2023). Therefore, mathematics is designated as a compulsory subject in schools (Suma et al., 2025). Nevertheless, mathematics learning is often considered one of the most difficult subjects for many students (Ade et al., 2022). Several supporting factors influence student success in school, particularly learning outcomes (Sulistiyono et al., 2022). Learning is each student's responsibility, and their learning outcomes depend on the abilities of each individual student (Baid et al., 2022).

However, mathematics is often considered a difficult subject by most students. According to (Saputro et al., 2021) students find mathematics challenging because they have to use formulas, the concepts are abstract, and there is a lack of learning media that can help visualize the material. A study by Sulistyarningsih in (Saputro et al., 2021) also shows that students' mathematical connection skills are generally low, which affects their academic performance and learning motivation. Hudoyono (Saputro et al., 2021) emphasizes that mathematics is related to ideas that are logically structured, so a strong conceptual understanding is needed to master it.

This issue is evident at SMP Negeri 2 Suwawa, where students' learning outcomes in the topic of quadrilateral plane figures remain relatively low. Students encounter difficulties in understanding the properties of plane figures when concepts are presented abstractly without visual or tactile support. Concrete instructional media—such as cardboard models or geometric manipulatives—are needed to help students visualize shapes more clearly and build stronger conceptual understanding. (Brinus et al., 2019) emphasize that effective learning outcomes depend greatly on the selection of appropriate instructional models that encourage students to link prior knowledge with new information. Similarly, studies by Riyana et al. (2020) and (Ninawati et al., 2022) demonstrate that the use of concrete media can significantly improve student motivation and learning outcomes. Sukmadinata (as cited in Ninawati et al., 2022) also notes that real objects provide meaningful stimuli that support students in understanding abstract material more easily.

Based on field observations at SMPN 2 Suwawa, students tend to be less active during lessons, show minimal engagement when concepts are explained, and participate only slightly in discussions. These patterns contribute to consistently low achievement in mathematics evaluations. Final assessment data indicates that student performance on the topic of quadrilaterals has remained below the Minimum Competency Criteria (KKM) for three consecutive academic years. In 2021/2022, only 6 of 32 students (18.75%) achieved the KKM; in 2022/2023, 4 of 22 students (18.18%) met the standard; and in 2023/2024, only 8 of 30 students (26.66%) passed. In total, 66 students failed to achieve the minimum criteria in quadrilaterals and triangles during this period, highlighting the need for improvement in teaching strategies and learning media.

However, mathematics is often considered a difficult subject by most students. According to (Saputro et al., 2021), students find mathematics challenging because it involves the use of formulas, abstract concepts, and a lack of learning media that can help visualize the material. The use of concrete learning media can help overcome these difficulties by transforming abstract mathematical concepts into tangible representations that are easier for students to understand. Previous studies have shown that concrete learning media positively affect

students' mathematics learning outcomes. For example, research by Bruner emphasizes that learning through enactive and iconic representations helps students build stronger conceptual understanding before moving to symbolic representations. Similarly, Sulistyaningsih (in Saputro et al., 2021) found that students' mathematical connection skills are generally low, which negatively impacts their achievement and learning motivation; however, these skills can be improved through the use of concrete media that connect mathematical concepts to real-life contexts. Hudoyono (Saputro et al., 2021) also states that mathematics consists of logically structured ideas, requiring strong conceptual understanding, which can be effectively developed through concrete learning media that support students in constructing mathematical concepts meaningfully.

METHOD

The method used in this study is the experimental research method. According to Sugiyono (Zyra et al., 2022), the experimental research method is a research method conducted through experimentation, which is a quantitative method employing a quasi-experimental approach (pseudo-experiment). This study involved all seventh-grade students of SMPN 2 Suwawa in the 2024/2025 academic year, totaling 77 students across four classes. The population, as described by Sugiyono (Husen, 2023), refers to all subjects possessing specific characteristics determined by the researcher for examination and conclusion drawing. Using a Pretest–Posttest Control Group Design, the sample was selected through simple random sampling. Two classes were chosen: one as the experimental group and the other as the control group. The experimental class used the Contextual Teaching and Learning (CTL) model supported by concrete object media, while the control class used the same model without concrete object media.

The use of concrete media in the experimental group was crucial in the learning process. The media used consisted of colored origami paper representing various plane geometric shapes such as squares, rectangles, and other plane figures. This media was expected to help students grasp abstract concepts more concretely and interactively. In this study, origami paper was used to assist students in visualizing geometric concepts that are difficult to understand through verbal explanations or theory alone. For example, the concrete object depicted in this study is colored origami paper that shows flat shapes which students can manipulate and arrange to understand various geometry concepts.



Figure 1. Colored origami paper used as concrete media in the experimental group to facilitate students' understanding of plane figures.

The data in this study are students' learning outcomes in the cognitive domain. Data collection in this study consisted of a pre-test and a post-test in the form of essay questions to measure students' mathematics learning outcomes on plane geometry material. The pre-test was administered to determine the students' initial abilities before treatment, while the post-test was given to measure learning outcomes after the implementation of the instructional model. Prior to use, the test instruments were examined for validity and reliability. The validity testing

consisted of two stages: expert (construct) validity and empirical validity using the Pearson Product Moment formula, while reliability was tested using Cronbach's Alpha.

The data analysis techniques included descriptive statistical analysis (mean, median, mode, and standard deviation) and inferential statistical analysis. Inferential analysis involved a normality test using the Shapiro Wilk procedure and a homogeneity test using the Levene for equality of variances. After the prerequisite tests were met, an independent t-test was used to determine differences in average learning outcomes between the experimental group taught using the CTL model supported by concrete object media and the control group taught using the same model without concrete object media. To measure the magnitude of the treatment effect, Cohen's d effect size was applied.

RESULTS AND DISCUSSION

Results

The research implementation in the experimental class was carried out in Grade VII.1 of SMPN 2 Suwawa with a total of 18 students. In this class, the learning process was conducted using concrete objects in the form of origami paper, supported by the Contextual Teaching and Learning (CTL) model. The learning activities were conducted over six meetings. In each meeting, students were given the opportunity to manipulate the origami paper by folding, cutting, and forming various quadrilateral shapes. The use of these materials aimed to help students better understand the properties of squares, rectangles, parallelograms, trapezoids, and rhombuses in a more concrete manner. At the initial stage, the teacher explained the learning objectives and provided examples of how to use origami as a tool to identify the shapes of plane figures, their properties, and to measure directly the dimensions of the figures they created. Next, students worked in groups to conduct hands-on activities, such as measuring the sides of the shapes, comparing different forms, and determining the perimeter and area of the origami results.

Throughout the learning process, students appeared actively engaged, as shown in the documentation where they collaboratively observe, fold, and analyze the origami sheets during group activities. The teacher acted as a facilitator who guided students through their exploration, making the learning process more interactive and student-centered. At the end of each meeting, students were given exercises to assess their understanding of the material learned. Learning with concrete objects in the experimental class showed that students were able to grasp the concepts of plane figures more easily because they could directly observe and manipulate the shapes, and this result is illustrated in Figure 2. Comparison of students' mathematics learning outcomes between the experimental class using concrete media and the control class without concrete media.



Figure 2. Students in the experimental class engaging in hands-on activities using origami paper as concrete media during the geometry learning process.

The research in the control class was conducted in Grade VII.2 of SMPN 2 Suwawa with a total of 18 students. In this class, learning was still carried out using the Contextual Teaching and Learning (CTL) model, but without the application of concrete objects. The instruction was delivered through CTL principles by connecting the material to real-life contexts, conducting group discussions, question-and-answer sessions, and problem-solving activities, but no manipulative activities using concrete media were included.

In delivering the quadrilateral plane geometry material, the researcher relied solely on the textbook, images provided in the book, and illustrations on the whiteboard as supporting visual sources. Students were still encouraged to observe, ask questions, and participate in discussions according to CTL components; however, the visualization of concepts did not involve origami folding or any other concrete objects. As a result, students received CTL-based instruction in a more abstract form, relying heavily on illustrations presented by the teacher.

During the learning process, several students appeared less active in asking questions or expressing their ideas due to the limited media available to help them understand the shapes and properties of quadrilaterals concretely. Although the structure of the lesson followed CTL stages, the absence of hands-on activities made it more difficult for some students to conceptualize the material. At the end of the lesson, students were given practice exercises as an assessment to measure their understanding of the content. Based on observations, some students still experienced difficulties in grasping the concepts of plane figures, which was likely due to the lack of concrete media to support the direct visualization of geometric shapes.

This study is an experimental research conducted at SMP Negeri 2 Suwawa with the aim of determining students' mathematics learning outcomes influenced by the application of the Contextual Teaching and Learning (CTL) model supported by concrete object media compared to the CTL model without media. A total of 36 students participated as the research sample, divided into two groups. The experimental group consisted of 18 students who were taught using the CTL model with concrete object media, while the control group consisted of 18 students who were taught using the CTL model without concrete media.

Data collection was carried out through two types of tests, namely the pretest and the post-test. Both instruments had been tested for validity and reliability. The test consisted of six essay items that were declared valid, with theoretical scores ranging from 0 to 18. The pretest and post-test data were then analyzed using descriptive statistics, including the mean, median, and standard deviation (SD).

Table 1. Description of Learning Outcomes Data

Class	Data	N	Min. Score	Max. Score	Mean (\bar{x})	Median (me)	Mode (Mo)	SD	varians
EKS	pretest	18	5	9	7,3	7,5	8	1,084	1,176
	posttest		14	18	15,8	16	16	0,963	0,928
KTRL	Pretest	18	5	9	6,5	6,5	6	1.199	1.437
	posttest		10	14	11,6	11,5	11	1,144	1,310

Based on the pretest and post-test results obtained from the experimental class, which was taught using the CTL learning model supported by concrete object media, the frequency distribution of students' learning outcomes can be presented in the following table

Table 2. Table of the frequency distribution of students' learning outcome data in the experimental class.

Pre test				posttest			
No	Class	f_i	$f_{relatif}$	No	Class	f_i	$f_{relatif}$
1	5	1	5,5	1	14	1	5,6
2	6	3	16,7	2	15	5	27,8
3	7	5	27,8	3	16	8	44,4
4	8	7	38,9	4	17	3	16,6
5	9	2	11,1	5	18	1	5,6
total		18	100	total		18	100

Table 2 shows that the pretest results indicate 9 students (50%) scored below the average and 9 students (50%) scored above the average. Meanwhile, in the post-test, 6 students (33.4%) scored below the average and 12 students (66.6%) scored above the average.

Referring to the pretest and post-test results obtained from the control class, the frequency distribution of students' learning outcomes can be presented in the following table.

Table 3. Table of the frequency distribution of students' learning outcome data in the control class.

Pre test				posttest			
No	Class	f_i	$f_{relatif}$	No	Class	f_i	$f_{relatif}$
1	5	4	22,2	1	10	3	16,7
2	6	5	27,8	2	11	6	33,3
3	7	5	27,8	3	12	5	27,8
4	8	3	16,7	4	13	3	16,7
5	9	1	5,5	5	14	1	5,5
total		18	100	total		18	100

The table shows that the pretest results indicate 9 students (50%) scored below the average and 9 students (50%) achieved scores above the average. Meanwhile, the post-test results show that 9 students (50%) remained below the average and 9 students (50%) were able to achieve scores above the average.

The normality test was conducted to determine whether the data collected in this study were normally distributed at a significance level of $\alpha = 0.05$. The Shapiro Wilk test was used to assess data normality. The criterion for this test is that H_0 indicates the data are normally distributed. The results of the normality analysis for both the pretest and post-test data whether in the experimental class taught using the CTL (Contextual Teaching and Learning) model supported by concrete object media or in the control class taught using the CTL model without concrete media are presented in the following table

Table 4. Results of the Data Normality Test.

Class	Test	W_{hitung}	W_{tabel}	Decision
Experimental	Pretest	0,9123	0,897	Data are normally distributed
	Post test	0,9143		
Control	Pretest	0,9151		
	Post test	0,9198		

Data that were already normally distributed were then tested for uniformity or homogeneity using the Harley test at a significance level of $\alpha = 0.05$. This testing procedure is designed to

determine whether the collected data show homogeneous variance. The decision criterion is as follows: if the calculated f value is less than the f table value, then the data from both groups have homogeneous and equivalent variances. This can be seen in the following table.

Table 5. Results of the Data Homogeneity Testing in Variance

Data	Class	n	dk	f_{hitung}	f_{tabel}	Decision
Pretest	Experimental	18	17	1,2222	2,2718	Homogeneous
	Control					
Post test	Experimental	18	17	1,4119	2,2718	Homogeneous
	Control					

Based on the data analysis above, it can be concluded that all four datasets meet the assumptions that the groups drawn from the population are normally distributed and homogeneous. Therefore, the requirements for conducting hypothesis testing using the T-test are fulfilled.

Table 6. Results of t-test

Data	Score mean		Dk	t_{hitung}	t_{tabel}	Decision
	Pretest	Posttest				
Experimen	16,5	35,75	34	6,1028	1,691	H_1 accepted
Control	16,3	29,02				

From the results of the hypothesis testing at a significance level of $\alpha = 0.05$, the calculated t value was obtained as $t_{\text{calculated}} = 6.1028$, which is greater than $t_{\text{table}} = 1.691$. Therefore, the hypothesis H_1 is accepted. This means that a statistically significant difference was found in mathematics learning outcomes between students who were taught using the CTL (Contextual Teaching and Learning) model with concrete object media and those who were taught using the CTL model without concrete object media. The learning outcomes show that students who participated in the learning process using the CTL model with concrete object media achieved an average score of 88.27. Meanwhile, students who were taught using the CTL model without concrete object media obtained an average score of 64.50.

Furthermore, based on the effect size calculation, a value of 2.1985 was obtained. It can be concluded that the CTL learning model using concrete object media has a very strong influence on improving students' mathematics learning outcomes, as this value falls within the "high effect" category according to Cohen's interpretation.

Discussions

The focus of this study was designed to determine the effect of using concrete media on mathematics learning outcomes in the topic of plane figures among Grade VII students at SMPN 2 Suwawa. A total of 36 students were selected as the sample, consisting of 18 students in the experimental class who received instruction using concrete objects through the Contextual Teaching and Learning (CTL) model, and 18 students in the control class who were taught using the same CTL model but without concrete media. The material studied was Plane Geometry (Bangun Datar). The data analysis revealed a statistically significant difference in learning outcomes between students in the experimental class and those in the control class. This result is supported by the t-test, which showed a value of $t(\text{calculated}) = 6.1028 > t(\text{table}) = 1.691$. This comparison was made using 34 degrees of freedom ($df = 34$) at a significance level of $\alpha = 0.05$. These findings strengthen the initial hypothesis that the use of concrete objects as learning media has an effect on the mathematics learning outcomes of Grade VII students at SMPN 2 Suwawa. Both instructional approaches—CTL using concrete media and CTL without

concrete media—had a positive impact on students' learning outcomes. However, the magnitude of the effect differed significantly, with the CTL approach that incorporated concrete media showing a stronger influence.

There is a significant difference in the learning outcomes of Grade VII students at SMPN 2 Suwawa between those taught using concrete media within the Contextual Teaching and Learning (CTL) model and those taught with the CTL model without concrete media. This difference is presumed to be influenced by the novelty of using concrete media. Such media help students transform abstract geometric concepts into more concrete and easily understandable forms. Learning with concrete media integrated into the Contextual Teaching and Learning (CTL) model in mathematics—particularly in the topic of Plane Figures—successfully creates an active, meaningful, and experience-oriented learning process. Through direct involvement in observing and manipulating concrete objects that represent various geometric shapes, students develop a stronger ability to understand and retain concepts. The use of concrete media combined with the CTL approach has a significant impact on improving student learning outcomes, as this combination reinforces contextual, constructivist, and hands-on learning aspects throughout the instructional process.

These findings are consistent with the study conducted by (Kurniawati & Mardiana, 2021), which showed that within the CTL framework, concrete objects serve as effective facilitators that enhance students' memory and understanding of plane geometry concepts. Similarly, the study by Ahmad Yani Sakti (2017) found that integrating concrete media into the CTL model provides a positive contribution to students' retention in mathematics learning. Furthermore, this research aligns with the findings of (Simamora & Simamora, 2022), who reported that the use of concrete media in mathematics instruction improves students' learning outcomes. Concrete media within the CTL learning model offer several advantages, including clarifying instructional messages to reduce excessive verbalism, overcoming limitations related to space, time, and sensory capacity, reducing student passivity through the use of diverse and appropriate learning media, and fostering a shared perception among students regarding the concepts being studied.

Learning with concrete media integrated into the Contextual Teaching and Learning (CTL) model creates a strong opportunity for students to enhance their retention and comprehension, making mathematics easier to understand and more enjoyable. This supportive and engaging learning atmosphere helps students feel more comfortable and motivated during mathematics lessons. As a result, their learning outcomes especially in the topic of plane geometry show significant improvement. Therefore, this model is highly suitable to be used as an effective alternative strategy for improving students' learning achievement.

CONCLUSION

This study concludes that the use of concrete object learning media within the Contextual Teaching and Learning (CTL) model significantly improves the mathematics learning outcomes of Grade VII students at SMPN 2 Suwawa, particularly in the topic of plane figures. Students who learned using concrete media achieved higher learning outcomes than those who received CTL instruction without concrete media, indicating that concrete media effectively support students in understanding abstract mathematical concepts.

Based on these findings, it is recommended that teachers integrate concrete learning media into mathematics instruction, especially for abstract topics. Future research may examine the application of concrete media in other mathematical materials, grade levels, or learning models, as well as explore their effects on other learning outcomes.

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