

The Effect of Problem-Based Learning Assisted by Magic Straw Media on Elementary School Students' Mathematical Conceptual Understanding

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Abstrak. Pemahaman konsep matematis merupakan kemampuan dasar yang penting dimiliki siswa karena menjadi landasan dalam mempelajari konsep matematika yang lebih kompleks. Namun, kemampuan pemahaman konsep matematis siswa sekolah dasar masih tergolong rendah. Penelitian ini bertujuan untuk mengetahui pengaruh model Problem Based Learning (PBL) berbantuan media Magic Straw terhadap kemampuan pemahaman konsep matematis siswa sekolah dasar. Penelitian ini menggunakan pendekatan kuantitatif dengan metode eksperimen dan desain one group pretest-posttest. Sampel penelitian berjumlah 20 siswa kelas VB SDIT Cendekia Purwakarta yang dipilih menggunakan teknik purposive sampling. Instrumen penelitian berupa tes uraian kemampuan pemahaman konsep matematis yang terdiri atas lima butir soal. Analisis data dilakukan menggunakan statistik deskriptif, uji normalitas, uji paired sample t-test, dan uji N-Gain dengan bantuan IBM SPSS Statistics 26. Hasil penelitian menunjukkan bahwa terdapat pengaruh yang signifikan dari penerapan model Problem Based Learning berbantuan media Magic Straw terhadap kemampuan pemahaman konsep matematis siswa dengan nilai signifikansi $< 0,05$. Selain itu, hasil uji N-Gain sebesar 0,5321 menunjukkan peningkatan kemampuan pemahaman konsep matematis pada kategori sedang. Dengan demikian, model Problem Based Learning berbantuan media Magic Straw dapat digunakan sebagai alternatif pembelajaran yang efektif untuk meningkatkan kemampuan pemahaman konsep matematis siswa sekolah dasar.

Kata kunci: Problem Based Learning, media magic straw, pemahaman konsep matematis, matematika, sekolah dasar

Abstract. Mathematical conceptual understanding is a fundamental ability that students need to master, as it serves as the foundation for learning more complex mathematical concepts. However, elementary school students' conceptual mathematical understanding remains relatively low. This research aimed to determine the effect of the Problem Based Learning (PBL) model assisted by Magic Straw media on students' mathematical conceptual understanding. The study employed a quantitative approach using an experimental method with a one-group pretest-posttest design. The sample consisted of 20 fifth-grade students from SDIT Ilmu Purwakarta selected through purposive sampling. The research instrument was an essay test consisting of five items designed to measure students' mathematical conceptual understanding. The data were analyzed using descriptive statistics, normality tests, paired sample t-tests, and N-Gain analysis with the assistance of IBM SPSS Statistics 26. The results revealed a significant effect of the Problem Based Learning model assisted by Magic Straw media on students'

mathematical conceptual understanding, indicated by a significant value of less than 0.05. Furthermore, the N-Gain score of 0.5321 indicated a moderate improvement in students' mathematical conceptual understanding. Therefore, the Problem Based Learning model assisted by Magic Straw media can be considered an effective alternative learning approach to improve elementary school students' mathematical conceptual understanding.

Keywords : Problem-Based Learning, magic straw media, mathematical conceptual understanding, mathematics, elementary school

INTRODUCTION

Education is a crucial factor in determining the quality of human resources. In general, education is a lifelong process aimed at developing the abilities of each individual to enable them to live and sustain their lives, thereby growing into educated individuals who are useful to the state, nation, and country (Siswondo & Agustina, 2021). Improving the quality of human resources can be achieved through improving the quality of education, one of which is through the process of mathematics learning (Destiniar et al., 2019). Therefore, mathematics learning plays a strategic role in shaping students' thinking skills and abilities in the modern era.

Mathematics learning plays a crucial role in education because it teaches students to develop logical, analytical, critical, and systematic thinking skills in addressing various problems. These skills are essential for students to adapt to the increasingly rapid developments in science and technology. Therefore, the quality of mathematics learning must be continuously improved through the development of innovative learning systems tailored to student needs. In line with the Independent Curriculum, mathematics learning is directed towards a collaborative, contextual, and reflective approach, enhancing students' conceptual understanding and critical thinking skills (Safari & Inayah, 2025).

In mathematics learning, understanding mathematical concepts is one of the fundamental skills students need to possess. This ability plays a crucial role because it serves as the foundation for understanding mathematical material and supports the development of other mathematical skills. Understanding mathematical concepts is a fundamental skill that must be developed in the mathematics learning process because it serves as the foundation for other mathematical skills (Afiani & Faradita, 2022). Students with a good conceptual understanding will more easily connect existing knowledge with new concepts, making the learning process more meaningful.

Understanding mathematical concepts is also one of the main goals in mathematics learning. Students are said to understand a concept if they can explain its definition in their own words, identify examples and non-examples, discover relationships between concepts, and apply the concept in various situations or contexts (Afiani & Faradita, 2022). Therefore, conceptual understanding emphasizes not only the ability to memorize formulas or procedures but also the ability to interpret and use mathematical concepts appropriately in problem-solving.

The importance of understanding basic mathematical concepts is also explained. Understanding concepts is the main foundation in mathematics learning because it helps students grasp the interrelationships between materials comprehensively. Students who understand basic concepts well will find it easier to follow more complex learning materials. Conversely, poor conceptual understanding can cause students to experience difficulty solving mathematical problems and impact poor learning outcomes (Safari & Nurhida, 2024).

Furthermore, mathematical understanding is also closely related to students' ability to interpret and apply mathematical concepts in everyday life. Mathematics learning that focuses on developing mathematical understanding can help students construct knowledge more meaningfully, ensuring that learned concepts are not easily forgotten (Rachmiati & Mansur, 2021). This demonstrates that mathematics learning should not only focus on the final result, but also on the process by which students understand the concepts learned.

To improve students' understanding of mathematical concepts, active, interactive learning is needed, directly involving students in the learning process. Learning models that provide opportunities for students to discuss, collaborate, and solve problems together can help students build their own understanding of mathematical concepts. The use of innovative learning models and the assistance of learning media can have a positive influence on elementary school students' understanding of mathematical concepts (Namira et al., 2024). Therefore, teachers need to choose appropriate learning models and media so that students can understand mathematical concepts more optimally and meaningfully.

However, the importance of mathematical conceptual understanding has not been matched by the quality of students' conceptual understanding in the classroom. In general, students still experience difficulty solving problems using different strategies and tend to simply follow the procedures or methods demonstrated by the teacher. This situation indicates that students' understanding of mathematical concepts is still procedural and has not yet reached a deep understanding. As a result, students' mathematical conceptual understanding remains low, requiring attention in the mathematics learning process.

The low level of students' mathematical conceptual understanding is also supported by various previous research findings. Research conducted at SDIT Persis Tarogong, Garut Regency, showed that students still experience errors in solving mathematical conceptual understanding problems and are unable to apply mathematical concepts or algorithms appropriately to a material (Maryati, 2023). These research results indicate that students do not yet have adequate skills in understanding and solving mathematical problems. Similar findings were also obtained from research at an elementary school in Rongga District, West Bandung Regency. Based on the results of data analysis from problem solving and learning implementation, some students obtained poor grades due to low conceptual understanding of the material being studied (Anggara & Samsudin, 2023). These facts indicate that elementary school students' mathematical conceptual understanding abilities are still relatively low and need to be improved through more effective and meaningful learning .

One effort that can be made to improve students' mathematical conceptual understanding is through selecting an appropriate learning model, one of which is by implementing the Problem Based Learning (PBL) model. The PBL model is a learning model that utilizes contextual or real-world problems as a starting point for learning with the aim of developing thinking skills, problem-solving abilities, and active student involvement in the learning process. Through problem-based learning, students are encouraged to discover and construct their own knowledge through a process of investigation and discussion. This is in line with the opinion that the application of the PBL model can improve students' mathematical conceptual understanding because it is able to encourage active student involvement in learning through solving contextual

problems relevant to everyday life (Nurhikmah et al., 2025). Thus, the PBL model is considered capable of creating a more meaningful and student-centered learning process.

In addition to selecting the right learning model, the use of interactive learning media also plays a crucial role in supporting the successful learning of mathematical concepts (Harmaen et al., 2024; Megawati & Prajono, 2024; Sutriyani, 2025). Concrete and interactive learning media can help students understand abstract mathematical concepts more easily. One such learning media that can be used in mathematics learning is Magic Straw.

Magic Straw media is a manipulative learning media made from plastic straws that can be arranged into various shapes, such as plane and solid shapes. The use of this media helps students visualize mathematical concepts concretely so that the learning process becomes more interesting and easier to understand. The use of Magic Straw can also encourage students to be more active in exploring concepts and solving mathematical problems. The use of Magic Straw can improve students' ability to understand mathematical concepts concretely and stimulate students' activeness in exploring and solving mathematical problems (Apriatni & Khaeroni, 2025). Therefore, the use of manipulative media such as Magic Straw is considered relevant to support mathematics learning in elementary schools.

Several previous studies have examined the influence of learning models and learning media on students' mathematical conceptual understanding. Research conducted on fifth-grade students at SD 5 Gondangmanis showed that the Problem-Based Learning model had a positive influence on students' mathematical conceptual understanding (Ula & Nugraha, 2023). However, this study did not utilize learning media that supported the learning process. Meanwhile, other research focused solely on the effectiveness of the Magic Straw media in mathematics learning without integrating it with a specific learning model (Apriatni & Khaeroni, 2025).

Based on the description above, this research presents a novelty by combining the Problem-Based Learning model with Magic Straw media in mathematics learning. The integration of the problem-based learning model with manipulative media is expected to create more interactive, contextual, and

meaningful learning, thereby optimally improving students' understanding of mathematical concepts, especially at the elementary school level.

RESEARCH METHODOLOGY

This research used a quantitative approach with an experimental research type. The research design used was a pre-experimental design with a one-group pretest-posttest design. This design involved one experimental group without a control group. In this design, students were first given an initial test (pretest) to determine their initial ability to understand mathematical concepts. Next, students were given treatment in the form of learning using the Problem Based Learning model assisted by Magic Straw media. After the treatment was given, students took a final test (posttest) to determine changes in their ability to understand mathematical concepts after the treatment was applied.

The population in this research was all fifth-grade students of SDIT Cendekia Purwakarta. The sampling technique used was purposive sampling, which is the selection of samples based on certain considerations and criteria relevant to the research objectives. The sample in this study consisted of 20 students from class VB. The study was conducted from April 14, 2026, to April 27, 2026.

The research instrument used was a mathematical concept comprehension test in the form of 5 essay questions. The instrument was developed based on five indicators of mathematical concept comprehension ability, namely: (1) restating a concept, (2) classifying objects according to the nature of the concept, (3) providing examples and non-examples of a concept, (4) presenting necessary or sufficient conditions for a concept, and (5) applying the concept in problem solving. Each correct answer was given a score of 4 and an incorrect answer was given a score of 1, so that the maximum score obtained by students was 20. Before being used in the research, the instrument was first tested for its suitability through validity, reliability, difficulty level, and question discrimination tests using IBM SPSS Statistics.

Data on mathematical concept understanding ability before and after treatment were analyzed using IBM SPSS Statistics version 26.0. Data analysis was carried out through several stages, namely descriptive statistics to see the general overview of the research data, normality test to determine data

distribution, N-Gain test to determine the increase in students' mathematical concept understanding ability, and paired sample t-test to determine significant differences between the pretest and posttest results after treatment.

RESULTS AND DISCUSSION

Results

The data collected in this study were students' scores that demonstrated an understanding of mathematical concepts before and after being given learning about the characteristics of triangles and quadrilaterals using PBL with the aid of magic straw media. The results of the study are described as follows:

1. Descriptive Statistical Analysis

Table 1 .

Descriptive Analysis of Data on Mathematical Concept Understanding Ability

No	Information	Pre-test	Post-test
1	Mean	48.00	74.50
2	Min score	30	40
3	Max score	70	100
4	Sd	11,965	13,563

Based on Table 1, the results of the descriptive statistical analysis show that there was an increase in students' mathematical concept understanding abilities before and after using PBL assisted by magic straw media, which was initially 48 to 75.5.

In the pretest, the standard deviation of 11.965 indicates that students' mathematical conceptual understanding scores before the treatment had a spread of approximately 11.965 points from the average value. In the posttest, the standard deviation of 13.563 indicates that students' mathematical conceptual understanding scores after the treatment had a spread of approximately 13.563 points from the average value. The standard deviation of the posttest was greater than that of the pretest ($13.563 > 11.965$), so the variation in students' scores after the treatment was slightly greater than before the learning. This indicates that the increase in students' abilities did not occur evenly, with some students experiencing very high increases, while others experienced lower increases.

To determine the significance of the improvement in students' mathematical conceptual understanding, inferential statistical tests will be conducted, including the N-Gain test and hypothesis testing. To determine whether to use a parametric or non-parametric test, the data distribution will first be checked to determine whether it is normally distributed.

2. Normality Test

A normality test was conducted to determine whether the pre-test data was normally distributed or not. The criteria for decision-making were: if the significance p-value (Sig.) was less than 0.05, then H_0 was rejected and the data was declared non-normally distributed. If it was greater than 0.05, then H_0 was accepted, so the data was declared normally distributed. The following are the results of the normality test for the pre-test and post-test data.

Table 2 .
Data Normality Test

No	Information	Statistics	Df	P(value)
1	<i>Pre-test</i>	0.950	20	0.373
2	<i>Post-test</i>	0.946	20	0.317

Based on Table 2, the p-values of the pretest and posttest data are 0.373 and 0.317, respectively. Both p-values are greater than 0.05, so the conclusion is that H_0 is accepted. In other words, the pre-test and post-test data are normally distributed. Because all data meet the assumption of normality, the data are suitable for analysis using parametric statistical tests in the next stage, namely the paired sample t-test.

3. N-Gain Score Test

This test was used to determine the extent of improvement in students' mathematical concept comprehension before and after being treated with the problem-based learning model assisted by the Magic Straw media. The categories were concluded by referring to the following N-Gain value categories:

Table 3.

N-Gain Categories

N-Gain Value	Category
$g \geq 0.70$	Tall
$0.30 \leq g < 0.70$	Currently
$g < 0.30$	Low

The results of the N-gain calculation of the data on students' mathematical concept understanding abilities before and after treatment are presented in Table 4 below.

Table 4.

N-Gain Score Test Result Data

N-Gain	N	Mean	Std. Error
Experimental Class	20	0.5321	0.04189

The N-Gain analysis showed a value of 0.5321, which is included in the moderate category. This result indicates that the application of the Problem Based Learning model assisted by Magic Straw media can improve students' mathematical concept understanding at a fairly effective level. In other words, after participating in the learning, students experienced an increase in mathematical concept understanding of 53.21% of the maximum possible increase.

4. Hypothesis Testing Using Paired Sample t- est

This test is conducted to test comparative hypotheses involving a single sample. The following hypotheses will be tested:

H_0 : There is no significant difference between the ability to understand mathematical concepts before using PBL assisted by magic straw and the ability to understand mathematical concepts after using PBL assisted by magic straw.

H_1 : There is a significant difference between the ability to understand mathematical concepts before using PBL assisted by magic straw and the ability to understand mathematical concepts after using PBL assisted by magic straw.

the p-value (2-way) was compared with $\alpha = 0.05$. If the p-value $> \alpha$, then H_0 is accepted and vice versa. The results of the paired sample t-test are presented in the following table.

Table 5.
Paired Sample t-Test Results (*p aired sample t-test*)

	Mean	Standard Deviation	T	Df	Sig. (2 tailed)
Pair <i>pretest</i> <i>posttest</i>	-5,300	1,658	-14,300	19	0,000

Based on the calculation results, the Sig. (2-tailed) value of 0.000 is smaller than 0.05. This indicates that H_0 is rejected. Thus, there is a significant difference between the ability to understand mathematical concepts before using PBL assisted by magic straw and the ability to understand mathematical concepts after using PBL assisted by magic straw.

Discussion

The results of the research indicate that the Problem Based Learning model assisted by Magic Straw media has a significant influence on students' mathematical concept understanding ability in Mathematics subjects in grade V of SDIT Cendekia Purwakarta. These results are shown through a paired sample t-test which obtained a significance value of less than 0.05. The findings of this research are in line with the results of research showing that the application of the Problem Based Learning model has a significant influence on students' mathematical concept understanding ability (Ula & Nugraha, 2023). In addition, the application of the Problem Based Learning model is also able to improve students' mathematical concept understanding ability because it encourages students' active involvement in the learning process through solving contextual problems relevant to real life (Nurhikmah et al., 2025).

The characteristics of Problem-Based Learning are closely related to indicators of mathematical concept comprehension in mathematics learning. Conceptually, Problem-Based Learning is a learning approach that utilizes contextual problems as a means for students to explore, acquire knowledge, and construct concepts independently to develop critical thinking and problem-solving skills (Nisak, 2023). This process aligns with the essence of

mathematical concept understanding, which emphasizes not only the ability to memorize formulas but also the ability to understand the meaning of a mathematical concept.

The Problem-Based Learning approach encourages students to restate concepts, apply concepts in various situations, and connect mathematical concepts to everyday life contexts. This is in accordance with the indicators of mathematical concept understanding abilities, which include the ability to restate concepts, present concepts in various forms of mathematical representation, and apply concepts or algorithms in problem solving (Hikmatulfazriyah et al., 2023; Apriliyana et al., 2023). Furthermore, the application of Problem-Based Learning in mathematics learning also helps students improve their understanding of mathematical concepts through investigation activities and group discussions. In this process, students are given the opportunity to test and revise their understanding so that the mathematical concepts learned become more meaningful (Sujalmo et al., 2024). Thus, Problem-Based Learning can be said to be a relevant and effective approach in improving elementary school students' mathematical concept understanding abilities.

Based on the posttest analysis results, students showed significant improvement in all indicators of mathematical concept understanding ability, especially in the indicator of restating a concept. This occurs because the Problem-Based Learning model requires students to first understand the material before re-explaining the concepts learned (Nisak, 2023). In problem-based learning, students are given ample opportunity to understand problems, discuss solutions, and re-communicate concepts in their own words before entering into abstract mathematical symbols or forms. The process of discussion, questions and answers, and presentation of investigation results indirectly train students to express concepts repeatedly so that the conceptual understanding obtained is not merely rote, but its meaning is truly understood. Furthermore, throughout the learning process, students were seen actively participating in discussions, observations, summarizing, and presenting the results of the investigations that have been conducted.

In addition to the implementation of the Problem-Based Learning model, the use of Magic Straw media also contributes to helping students understand

mathematical concepts in a more concrete and engaging way. Magic Straw media is presented in three-dimensional form and is interactive, enabling the visualization of abstract concepts to become more tangible in mathematics learning, particularly in the field of plane geometry. This media helps students comprehend information through more concrete visualizations, making the learning process easier to understand and more enjoyable.

The use of Magic Straw media also trains students' accuracy through the activity of carefully arranging and arranging materials. Furthermore, this media can stimulate students' language and expression skills because they are encouraged to communicate the process and results of their work. Magic Straw media is used as a learning medium that supports the learning process both individually and in groups, both inside and outside the classroom (Rani, 2024). The visualizations in the media not only function to attract students' attention but also strengthen students' cognitive processes in analyzing information, observing conceptual forms, comparing concepts, and grouping mathematical concepts.

Previous research has also shown that the use of Magic Straw media can increase students' interest in actively and creatively engaging in learning activities. The activity of assembling Magic Straws can stimulate students' imagination and increase their engagement in learning (Anaureta et al., 2024). Furthermore, the use of Magic Straws can also encourage students' interest in learning through play. With engaging visualizations, this media can enhance students' cognitive development and motivation in honing their ability to assemble geometric shapes in various shapes and colors (Qibtiyah et al., 2021).

Based on the description above, it can be concluded that the combination of the Problem Based Learning model and Magic Straw media has a positive influence on improving students' mathematical concept understanding abilities. Through the problem-solving process supported by concrete and interactive media, students become more active in restating concepts, classifying objects, providing examples and non-examples, developing the conditions for a concept, and presenting mathematical concepts in various forms of representation. Although this study has limitations because it does not involve a control class, the study was still conducted systematically through the administration of pretests and posttests to see changes in student abilities. Therefore, the results

of this research can still provide an overview of the effect of implementing the Problem Based Learning model assisted by Magic Straw media on improving elementary school students' mathematical concept understanding abilities.

CONCLUSION

The findings of this study indicate that the implementation of the Problem Based Learning (PBL) model assisted by Magic Straw media significantly improved students' mathematical conceptual understanding. The mean score increased from 48.00 in the pretest to 74.50 in the posttest, with an N-Gain score of 0.5321, indicating a moderate level of improvement. Furthermore, the paired sample t-test showed a significance value of 0.000 (< 0.05), confirming a significant difference between students' conceptual understanding before and after the intervention. Therefore, PBL assisted by Magic Straw media can be considered an effective approach for enhancing elementary school students' understanding of mathematical concepts.

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