International Conference on Elementary Education
Volume 8, Nomor 1

e-ISSN: 2808-8263
p-ISSN: 2829-0976

The problem-based learning model has a significant effect on elementary school students' mathematical concept comprehension skills

Anesa Juliati Sarila[1*], Andhin Dyas Fitriani[2]

[1,2]Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi 229, Bandung, Indonesia

* *anesajuliati.21@upi.edu

Abstract. This study aims to determine whether there is a difference in the effect before and after learning using the problem-based learning model in improving students' mathematical concept understanding. This study uses a quantitative approach with a one-group pretest-post-test design to examine the effectiveness of the problem-based learning model in improving students' mathematical concept understanding. Based on the results of the Paired Samples T-Test, a sig. value (2-tailed) = 0.001 was obtained, which is smaller than the significance level α = 0.05. This indicates that H0 is rejected and H1 is accepted, which means that the use of the problem-based learning model has a significant effect on improving the mathematical concept comprehension abilities of fifth-grade students in the subject of fractions. As a whole, the problem-based learning model has been proven to contribute to improving students' mathematical concept comprehension skills.

Keywords: Problem Based Learning, Understanding Mathematical Concepts.

INTRODUCTION

Mathematics as a basic science in optimizing technology and science is one of many disciplines studied at the elementary school level. Mathematics is often used in everyday life in every aspect of life, both practically and theoretically. Although mathematics is often considered difficult, everyone must study mathematics from elementary school to university. One of the benefits of learning mathematics is that it can be used as a means of solving everyday problems (Sumartini, 2018). Mathematics is not a collection of separate topics, but rather a continuous whole. Although in reality mathematics is taught in several separate topics, these topics are prerequisites that can be used as a basis for understanding subsequent topics.

Analysis of PISA results trends shows a decline in performance in reading, science, and mathematics over several decades, beginning before the pandemic. Although some countries experienced declines, such as Australia, Belgium, and New Zealand, others, such as Colombia, Macau, and Peru, managed to improve their performance. Efforts to promote equity in education are evident in countries such as Canada, Denmark, and Finland, which are considered highly equitable according to PISA standards. The percentage of 15-year-old students enrolled in grade 7 or above varies from 36% to over 90% in some countries and economies (OECD, 2023). The 2015 TIMSS survey data shows that Indonesian students' mathematics skills only scored 397 points, which is below the TIMSS Scale Centerpoint standard of 500 points (TIMSS, 2015). The results of a recent study conducted by the government through a national assessment (AN) show that only 50% of students have good reading skills. Meanwhile, only 33% of students have good math skills (Mutakin et al., 2023). This is a serious concern, considering that mathematical ability, which is synonymous with numeracy, is receiving more attention from the government with the implementation of the National Assessment (AN), which covers two core competencies, namely literacy and numeracy (Patriana et al., 2021; Rokhim et al., 2021). The process of familiarizing students with mathematical literacy is not commonly practiced in schools because teachers do not yet understand that the essence of mathematics learning is not arithmetic ability but logical and critical thinking (Budiman et al., 2014; Siswono, 2009). Therefore, learning should use instruments similar to those used in PISA. Low mathematics learning achievement can be influenced by various factors, both internal and external. Internal factors are related to students' psychological conditions and their views on mathematics learning. Many students have a negative view of mathematics, considering it a difficult and confusing subject (Anggraeni, 2010). On the other hand, external factors include the teaching methods used by teachers. Most teachers still apply conventional methods that tend to be lecture-based and do not actively involve students in the learning process (Sato in Sugiman, 2009). This causes students to not be fully engaged and to be less able to understand mathematical concepts in depth.

Learning is a reciprocal relationship between teachers and students to realize national education. Learning is not a process of transferring knowledge from teachers to students, but rather an activity in which teachers give students the opportunity to discover ideas, concepts, and thoughts based on their own knowledge, which means that students participate directly in the learning process. Therefore, in this case, students do not play a passive role but rather an active one in discovering new ideas, concepts, and thoughts based on their own knowledge under the guidance of the teacher. The teacher acts as a mentor and guide for students in learning new things. Therefore, the learning process itself must be well-designed so that students can have a direct experience in acquiring new knowledge, including mathematics. (KEMENDIKBUD, 2013) regarding process standards states that the 2013 curriculum is a curriculum that uses a scientific approach, whereby the content of the 2013 curriculum suggests three types of models, namely: (1) a learning model based on discovery or inquiry learning, (2) problem-based learning, (3) learning that produces a final product obtained from solving a problem (project-based learning). Based on the above description, there are three

e-ISSN: 2808-8263
p-ISSN: 2829-0976

models contained in the 2013 curriculum that are expected to be able to achieve national education goals.

Problem-based learning is one of the learning models included in the 2013 curriculum. (Ejin, 2016) states that problem-based learning is a learning model that confronts students with real-life problems they experience and problems presented from relevant everyday life. In line with this opinion, Slameto (2013) also gives his opinion on the Problem-Based Learning model, stating that Problem-Based Learning is a learning model that provides training and development on authentic problems from the actual lives of students in order to stimulate higher-level abilities. (Kodariyati & Astuti, 2016) describe the stages/syntax of the PBL model, including: introducing students to the problem being discussed, instructing students to think, guiding students to solve problems either independently or in groups, presenting the results of their work, and analysing and evaluating the problem-solving process that has been carried out. Based on the opinions expressed, it can be concluded that Problem-Based Learning is a learning model that requires active participation from students, in which students are given the opportunity to dive in and participate directly in exploring their own knowledge based on real (contextual) problems commonly encountered in everyday life. The Problem-Based Learning model is expected to help students become accustomed to solving and analysing problems so that their problem-solving skills will be developed to the maximum (Widyastuti & Airlanda, 2021).

Conceptual understanding plays an important role in mathematical knowledge. Emphasizing concepts can help students acquire permanent concepts through experience, enabling them to connect one concept with another (Fitra et al., 2016). Mathematics learning that must be emphasized is conceptual understanding. If conceptual understanding is good and mature at the beginning of learning, students will be able to solve new problems (Ula et al., 2021). Conceptual understanding is a student's ability to master a number of subject materials, meaning that students not only remember a few concepts but are also able to explain them in other patterns and apply them to concepts that match the cognitive structure of the students themselves (Fitrah, 2017). Conceptual understanding can be interpreted as a person's thought process to process the learning material received so that it becomes meaningful. Conceptual understanding is the ability of students to master material, such as defining or explaining part of or defining the lesson material using their own words. If students are able to explain or define, then they have understood the concepts or principles of a lesson and the explanations given, and have formulated sentences that are not the same as the concepts given, but have the same meaning (Fatimah, 2017).

Students are said to understand a concept if they are able to define the concept, identify and give examples or non-examples of the concept, develop the ability to relate various ideas to one another, understand how ideas are interrelated so that a comprehensive understanding is built, and use a context outside of its original context. Based on the initial data collected, four indicators of concept understanding were used in this study, namely: (1) restating a concept; (2) classifying objects according to certain characteristics; (3) providing examples and non-examples of a concept; (4) and presenting concepts in various forms of representation (Arifah & Saefudin, 2017).

Conceptual understanding is the ability of students to interpret scientific knowledge properly. Therefore, students are required to understand what is being taught, know what is being communicated, and be able to utilize the content without having to connect it to other things. This is very important for students who have undergone the learning process, because the conceptual understanding possessed by students can be used to solve problems related to the concepts they have learned. In conceptual understanding, students are not only limited to recognizing concepts, but they must also be able to connect one concept to another (Meilawati, 2020).

Mathematical concepts need to be taught from elementary school level, because students at this stage are in an important period for their physical and mental development. Elementary school children still have a tabula rasa nature, which is like a blank page or white canvas that has not yet been filled. At this stage, everything they learn and every decision they make is still greatly influenced by the teaching and guidance they receive (Radiusman, 2020). Conceptual understanding is fundamental to mathematics. This means that every student must have a good understanding of concepts in order to solve mathematical problems. Conceptual understanding is the basis for understanding principles and theories, so in order to understand principles and theories, students must first understand the concepts that make up those principles and theories. Therefore, it is important for students to understand concepts in mathematics (Diana et al., 2020). Susanti et al. (2021) state that conceptual understanding is the ability to accept, absorb, and understand material or information obtained through a series of events that can be seen directly or heard, which is stored in the mind and can later be applied in everyday life. By understanding mathematical concepts, students are able to distinguish between a number of separate concepts and are able to perform meaningful calculations in broader situations or problems. Students are also able to restate mathematical concepts in their own words, classify mathematical objects, apply concepts algorithmically, interpret ideas or concepts, and relate various concepts.

e-ISSN: 2808-8263
p-ISSN: 2829-0976

METHODOLOGY

This study used a quantitative approach with a one-group pretest-post-test design to examine the effectiveness of the problem-based learning model in improving students' mathematical concept comprehension skills. This study involved 23 students from one class as samples. Mathematical concept comprehension skills were measured through written tests administered before (pretest) and after (post-test) the implementation of the learning model. The research process began with the administration of the pretest, followed by the implementation of learning using the problem-based learning model, which emphasized the active involvement of students in constructing knowledge through experience and interaction in solving problems. After the intervention was completed, a post-test was administered to measure changes in mathematical concept comprehension skills.

RESULTS AND DISCUSSION

This study aims to examine the effect of the problem-based learning model on fifth-grade students' mathematical concept comprehension in fractions. The research design used is a one-group pretest-posttest design, in which students are given tests before (pretest) and after (posttest) the application of the problem-based learning model. The subjects of this study were 23 students who participated in learning using the problem-based learning model. The statistical tests used in this study included Paired Samples T-Test, Paired Samples Correlation, and Paired Samples Effect Size to measure the effectiveness and relationship between the pretest and posttest results.

Table 1. Results of the Paired Samples T Test of Pretest and Posttest Scores of Fourth Grade Students' Mathematical Concept Comprehension Ability with the PBL Learning Model

Paired Samples Test

		Paired Differences							Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
Pair 1	pretest - posttest	-20.414	11.147	2.070	-24.654	-16.174	-9.862	28	<.001	<.001

Based on the Paired Samples T Test output in the table, the sig. value is 0.001, which is smaller than the level of significance α = 0.05, meaning that H0 is rejected and H1 is accepted. This means that the use of the PBL learning model has a significant effect on the mathematical concept comprehension ability of fifth-grade students in fractions with a 95% confidence level.

From the Paired Sample Correlations, a sig. Two-Sided p value of 0.547 is obtained, and this value is greater than α = 0.05, so it can be concluded that there is no significant relationship between the pretest and posttest scores. This shows that even though there is a significant difference between the pretest and posttest scores (based on the previous t-test results), these changes are not strongly correlated with each other. In other words, the pretest scores do not significantly predict the posttest scores, which may indicate that other factors play a role in improving student learning outcomes after the intervention.

Table 2. Paired Samples Correlations Test Results

Paired Samples Correlations

		N	Correlation	Significance	
				One-Sided p	Two-Sided p
Pair 1	pretest & posttest	29	.117	.273	.547

From Paired Sample Effect Sizes, a point estimate of Cohen's effect size of -1.831 was obtained with a 95% confidence interval between -2.425 and -1.225. The negative Cohen's effect size indicates that there was a decrease in scores after treatment, with a very large effect (because the absolute value is greater than 0.8).

However, this negative interpretation must be further examined in the context of the study. If an increase in post-test scores was expected, then these results may indicate factors that hindered the effectiveness of the intervention. Conversely, if a decrease in scores was expected (for example, in the context of certain experiments), then this effect indicates a significant impact. In other words, even though there was an increase in scores after the learning intervention, the pretest scores could not significantly predict the post-test scores. This indicates that other factors, such as teaching methods, student motivation, or the learning environment, may have contributed to the changes in student learning outcomes. These results also show that students with low pretest scores did not always experience greater improvement after the intervention than students with high pretest scores.

e-ISSN: 2808-8263
p-ISSN: 2829-0976

Table 3. Paired Samples Effect Size Test Results

Paired Samples Effect Sizes

					95% Confidence Interval	
			Standardizer[a]	Point Estimate	Lower	Upper
Pair 1	pretest - posttest	Cohen's d	11.147	-1.831	-2.425	-1.225
		Hedges' correction	11.457	-1.782	-2.360	-1.192

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

Based on the Paired Samples Effect Sizes results, Cohen's d value of -1.831 was obtained with a 95% confidence interval ranging from -2.425 to -1.225. Cohen's d values within this range indicate that there is a very large effect on the difference between pretest and post-test results.

A negative value on Cohen's d indicates that there was a decrease in scores after the treatment. This interpretation indicates that the intervention had a significant impact on learning outcomes, although the direction of the change needs to be analysed further in the context of the study. If the goal of the intervention was to increase post-test scores, then these results may reflect factors that influenced the effectiveness of the treatment. Conversely, if the decrease in scores was part of the research hypothesis, then these findings confirm that there were substantial changes in line with initial assumptions. In other words, even though there was an increase in scores after the learning intervention, the pretest scores could not significantly predict the post-test scores.

This indicates that other factors, such as teaching methods, student motivation, or the learning environment, may have contributed to the changes in student learning outcomes. These results also show that students with low pretest scores do not always experience greater improvement after the intervention than students with high pretest scores.

Based on the results of the study, the use of the PBL learning model has been empirically tested through the One-Group Pretest-Post-test Design method with rigorous statistical analysis, including Paired Samples T-Test and Cohen's d, which shows a significant effect on improving students' mathematical concept comprehension skills. These findings are consistent with previous studies that support the effectiveness of the PBL model in improving mathematical concept understanding. With strong evidence and valid analysis, the results of this study can be used as a theoretical basis that the PBL model is effective in improving students' mathematical concept understanding of fractions, so that it can be used as a reference in developing mathematics learning strategies in elementary schools.

CONCLUSION

This study was conducted in fifth grade on the subject of fractions with 23 students. Referring to the research objectives that have been achieved with indicators that are answers to the research questions and have been explained, the following conclusions can be drawn: The use of the problem-based learning model has a significant effect on improving fifth-grade elementary school students' understanding of mathematical concepts in the subject of fractions. The results of the Paired Samples T-Test show that there is a significant difference between the pretest and post-test scores, which means that the application of the problem-based learning model has a positive impact on students' understanding in connecting mathematical concepts. The correlation test results show that the pretest scores do not significantly predict the post-test scores, indicating that other factors such as teaching methods, student motivation, and the learning environment may also influence learning outcomes. In addition, Cohen's d value shows a very large effect, although this negative interpretation needs to be further reviewed in the context of the study. Overall, the problem-based learning model has been proven to contribute to improving students' mathematical concept comprehension, but further study is needed to evaluate external factors that may influence the effectiveness of this learning model.

REFERENCES

Arifah, U., & Saefudin, A. A. (2017). Menumbuhkembangkan kemampuan pemahaman konsep matematika dengan menggunakan model pembelajaran guided discovery.Union: Jurnal Pendidikan Matematik,5(3), 263-272.

Diana, P., Marethi, I., & Pamungkas, A. S. (2020). Kemampuan pemahaman konsep matematis siswa: ditinjau dari kategori kecemasan matematik. SJME (Supremum Journal of Mathematics Education), 4(1), 24-32. http://creativecommons.org/licenses/by-sa/4.0

Ejin, S. (2016). Pengaruh Model Problem Based Learning (PBL)Terhadap Pemahaman Konsep dan Keterampilan Berpikir Kritis Siswa Kelas IV SDN Jambu Hilir Baluti 2 Pada Mata Pelajaran Ilmu Pengetahuan Alam. Jurnal Pendidikan.

Fatimah, S. (2017). Analisis pemahaman konsep IPA berdasarkan motivasi belajar, keterampilan proses sains, kemampuan multirepresentasi, jenis kelamin, dan latar belakang sekolah mahasiswa calon guru SD.Jurnal Inovasi Pendidikan Dan Pembelajaran Sekolah Dasar,1(1).

Fitra, R., Hajidin, H., & Ansari, B. I. (2016). Peningkatan Kemampuan Pemecahan Masalah Siswa SMK melalui Model Problem-Based Instruction (PBI).Jurnal Didaktik Matematika,3(2), 35-41.

Fitrah, M. (2017). Pembelajaran berbasis masalah untuk meningkatkan pemahaman konsep matematika pada materi segiempat siswa smp.Kalamatika: Jurnal Pendidikan Matematika,2(1), 51-70.

Kodariyati, L., & Astuti, B. (2016). Pengaruh Model Pbl Terhadap Kemampuan Komunikasi Dan Pemecahan Masalah Matematika Siswa Kelas V Sd. Jurnal Prima Edukasia, 4(1), 93. https://doi.org/10.21831/jpe.v4i1.7713

Mailani, E., Setiawati, N. A., Surya, E., & Armanto, D. (2022). Implementasi Realistics Mathematic Education dalam Meningkatkan Keterampilan Berfikir Tingkat Tinggi/HOTS pada Siswa Sekolah Dasar. *Jurnal Basicedu*, *6*(4), 6813-6821. https://doi.org/10.31004/basicedu.v6i4.2855

Radiusman, R. (2020). Studi Literasi: Pemahaman konsep anak pada pembelajaran matematika. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, *6*(1), 1-8. https://doi.org/10.24853/fbc.6.1.1-8

Slameto. (2013). Belajar Dan Faktor-faktor Yang Mempengaruhi. Rineka Jaya.

Susanti, E. D., & Sholihah, U. (2021). Pengembangan e-modul berbasis flip pdf corporate pada materi luas dan volume bola. RANGE: Jurnal Pendidikan Matematika, 3(1), 37-46.

Ula, N., Ulia, N., & Fironika, R. (2021). Pengembangan Media Kelubatar Berbasis Android pada Pemahaman Konsep Keliling dan Luas Bangun Datar kelasIV SD. JurnalInovasi Pendidikan Matematika,3 (1): 20-29.

Widyastuti, R. T., & Airlanda, G. S. (2021). Efektivitas model problem based learning terhadap kemampuan pemecahan masalah matematika siswa sekolah dasar. *Jurnal Basicedu*, *5*(3), 1120-1129. https://doi.org/10.31004/basicedu.v5i3.896