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THE EFFECT OF PROBLEM-BASED LEARNING MODEL ON ADAPTIVE REASONING ABILITY IN MATHEMATICS CLASS V ELEMENTARY SCHOOL

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Abstract

The primary aim of this study is to enhance students' adaptive reasoning ability by applying the problem-based learning model. The chosen method, a pseudo-experiment with a non-equivalent control group design, was selected for its rigorous approach, instilling confidence in the research process. The population consisted of 105 students in class V, with a sample of 41 students selected, divided into 21 students in the control class and 20 in the experimental class, determined by the purposive sampling technique. The instrument used was a test to assess adaptive reasoning skills. The data analysis, conducted with an independent T-Test, revealed that the adaptive reasoning ability with the PBL model was higher than that of students who applied the expository learning model. These findings, based on a robust methodology, suggest that the PBL model has the potential to significantly enhance students' adaptive reasoning skills in mathematics.

Keywords: Adaptive reasoning ability, Mathematics, Problem-based learning

Abstrak

Meningkatkan kemampuan penalaran adaptif peserta didik melalui penerapan model pembelajaran problem based learning merupakan tujuan utama dalam penelitian ini. Metode eksperimen semu adalah metode yang dipilih dengan non-equivalent control group design. Sejumlah 105 peserta didik di kelas V menjadi populasi dan banyaknya sampel yang dipilih berjumlah 41 peserta didik terbagi menjadi 21 peserta didik kelas kontrol dan 20 kelas eksperimen yang ditentukan dengan teknik purposive sampling. Instrumen yang digunakan berupa tes untuk mengetahui kemampuan penalaran adaptif. Berdasarkan hasil analisis data yang dilakukan dengan Uji-T independent menunjukkan bahwa kemampuan penalaran adaptif dengan model PBL lebih tinggi dibanding peserta didik yang menerapkan model pembelajaran ekspositori. Berdasarkan hal tersebut, menunjukkan bahwa hasil penelitian pada pembelajaran matematika dengan menerapkan model PBL memiliki potensi untuk meningkatkan kemampuan penalaran adaptif peserta didik.

kata kunci: Kemampuan penalaran adaptif, Matematika, Problem based learning

INTRODUCTION

Technology and science continue to develop actively in the world of education. This statement aligns with Herutomo and Marianingsih (Marbun et al., 2022), who stated that education is essential to technological and scientific advancement because education produces human potential that can harmonize with changing circumstances. Among other subjects, mathematics is found in the field of education. Mathematics learning is a significant discipline that increases one's ability to think and argue (Marasabessy, 2021). Novianti and Khoirotunnisa, quoted by Maghfirah (Marbun et al., 2022), define mathematics learning as an educational process that develops from the basic to higher mathematical concepts through

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the discussion of mathematical topics that are organized hierarchically, organized logically, and integrated. Mathematics learning in elementary schools is based on mathematical concepts and functions as a teaching tool and resource for students (Zahra et al., 2020).

The five basic skills of mathematics learning that must be mastered are the ability to solve a problem, communicate, reason, connect, and represent (Marasabessy, 2021). Bernard's words (Oktaviana & Haryadi, 2020a) In mathematics, students need reasoning to generate ideas or ideas when solving problems to help them know mathematical topics and concepts accurately. According to Ostler (Ansari et al., 2020) Students are skilled in solving a problem at the creation level because they can think inductively, deductively, and intuitively. Therefore, there is a relationship between inductive, deductive, and intuitive thinking skills and higher-level thinking skills. Nopitasari (Oktaviana & Haryadi, 2020a) Revealed that students learning mathematics are expected to understand various reasoning, including inductive, deductive, and intuitive reasoning, where the three reasoning are contained in adaptive reasoning. According to Milgram (Darwani et al., 2020) Adaptive reasoning, a key concept in this study, is the skill of logical thinking, estimating answers, providing explanations related to the ideas used in answers, and assessing mathematical correctness. There are five indicators of adaptive reasoning ability, according to Shechtman (Darmayanti et al., 2022) are:

1. The ability to test an argument or explore an idea.
2. The ability to find patterns in a mathematical problem.
3. The ability to formulate a conjecture or hypothesis
4. The ability to conclude a statement or solve a problem.
5. Ability to reason for the answers given.

However, in mathematics learning, the adaptive reasoning ability of students is still relatively low. A study conducted by (Wasiran & Andinasari, 2019) said that adaptive reasoning and creative thinking skills in students are still not carried out optimally. Another research conducted by (Marbun et al., 2022) said that the overall percentage of students' ability in mathematical adaptive reasoning was 29%; it can be concluded that the adaptive reasoning ability in the school is still somewhat lacking. Furthermore, (Oktaviana & Haryadi, 2020a) concluded that students' ability to adaptive reasoning is still low or lacking. The next researcher (Darwani et al., 2020) said that during the observation of 29 students, it was

revealed that most students had several mathematical skills, such as procedural fluency and conceptual understanding. Still, students had low adaptive reasoning and strategic competence.

The causative factor of low or lack of adaptive reasoning ability in students is when teachers only transfer knowledge and students listen to explanations. So, learning becomes tedious and difficult to understand, and students do not actively participate in learning activities. This is because the learning model used is still teacher-centered, which makes students' learning process too dependent on their teachers in all learning affairs. Students only receive the material provided by the teacher without trying to dig deeper into material from other sources. Furthermore, students only focus on completing assignments to lower their motivation and enthusiasm for learning. This problem needs to be overcome and tried to be improved.

Based on these problems, the reasoning ability of students can be developed by making decisions to choose to use a learning model based on the concept of problem-solving. According to Kurniawati (Marbun et al., 2022), When a person is honing their problem-solving skills, he is developing thinking and basic reasoning learning skills to use the understanding he has gained in dealing with a problem. The problem-based learning (PBL) model effectively addresses these problems. The PBL model uses issues to be solved by students and uses all the information that students have or have as answers and solutions to solve the issues they face (Putra & Widyasari, 2023). According to Padmavathy and Mareesh (Oktaviana & Haryadi, 2020b) Stated that PBL provides opportunities for students to increase their capacity to think critically in the learning process when the learning process plays an active role, participates in discussions, and provides motivation in group learning activities. The PBL model is believed to help students solve problems, collect as much information as possible, and exchange opinions about the material they understand.

Many researchers have conducted research to improve adaptive reasoning skills. However, they are still at the university level, as has been done by (Wasiran & Andinasari, 2019) about incorporating instructional methods based on creative problem solving to increase mathematics students' capacity to succeed in their creative thinking and adaptive reasoning. Another researcher (Oktaviana & Haryadi, 2020a) explained how reciprocal

teaching can improve adaptive reasoning and the next researcher (Oktaviyanthi & Agus, 2020) It aimed to improve students' mathematical adaptive reasoning.

As for those who have conducted research on PBL in elementary schools, it focuses more on student's ability to solve elementary school math problems conducted by (Widyastuti & Airlanda, 2021). Then, research on PBL focuses more on students' ability to think critically, which has been carried out by researchers (Utaminingsih et al., 2022), and other researchers conducted by (Cahayaningsih et al., 2023) researched About PBL on students' proficiency in mathematics. Based on the explanation above, no research has been conducted to improve elementary school student's ability to use adaptive reasoning with the PBL model. Therefore, this study has novelties related to improved mathematical adaptive reasoning skills at the elementary school level.

METHOD

This study is a quantitative research using a pseudo-experimental design type. According to (Sugiyono, 2021) Implementing experimental design is challenging because it evolved from actual experimental design. In this study, a nonequivalent control group design form is applied. According to (Sugiyono, 2021) This design is almost like a pretest-posttest control group design. However, this design did not randomly select the experimental and control groups. This study uses two classes, namely the experimental and control classes, with the instruments used, namely tests and documentation. According to (Hikmawati, 2020) Revealed that a test is a set of exercises, questions, and other tools used to assess the knowledge, skills, intelligence, and abilities or talents of a group or individual and the form of Documentation, namely Images, written words, or a person's colossal work (Sugiyono, 2021). The test given describes five questions based on indicators of adaptive reasoning ability. Here is Table 1. related to the instrument grid based on indicators of adaptive reasoning ability.

Table 1. Adaptive reasoning ability grid

Types of Abilities	Indicator	Question indicators	No Item
Adaptive reasoning ability	Ability to formulate conjectures or hypotheses.	Students can formulate conjectures	1
	Ability to give reasons for the answers given.	Students can give reasons related to the chosen answer	2

	The ability to conclude a statement or solve a problem.	Students can give conclusions from a statement	3
	The ability to test an argument or explore an idea.	Students can investigate the truth of a statement contained in the problem	4
	The ability to find patterns in a mathematical problem.	Students can find patterns from existing statements to mathematical sentences	5

Before the test is carried out, the instrument is tested first to determine the validity, reliability, level of difficulty, and discriminating power. In the validation test, this study used both content and field validation. Content validation using material and language validators to check the extent of the compatibility between the instrument and the material and the debate. Furthermore, the field validation in this study used Pearson's product-moment formula, and the results of the management showed that out of the 10 questions that were tested, there were 3 invalid questions. In the reliability test which tests whether the instrument is reliable or not, using Alpha Cronbach shows a reliable result of 0.86. The differentiating power analysis showed 2 questions in the category of very good, 3 good, 4 adequate, and 1 bad. The difficulty level analysis also shows 8 questions of medium difficulty, 1 easy, and 1 very easy. Based on these results, the following table of selection of questions for the adaptive reasoning ability test can be seen in Table 2.

Table 2. Question Selection

No	Validity		Reliability		Differentiating Power		Difficulty Level		Results
	Score	Info	Score	Info	Score	Info	Score	Info	
1	0,741	Very Significant			47,62	Good	57.14	Average	Not Use
2	0,841	Very Significant			90,48	Very Good	50.00	Average	Use
3	0,577	Significant		R E L I A B L E	38,10	Moderate	61.90	Average	Use
4	0,425	-			19,05	Bad	42.86	Average	Not Use
5	0,377	-			42,86	Good	45.24	Average	Not Use
6	0,588	Significant	0,86		33,33	Moderate	40.48	Average	Use
7	0,638	Significant			38,10	Moderate	80.95	Very Easy	Use
8	0,433	-			33,33	Moderate	30.95	Average	Not Use
9	0,726	Very Significant			61,90	Good	50.00	Average	Not Use
10	0,779	Very Significant			85,71	Very Good	42.86	Average	Use

Based on Table 2, the selected questions are 2, 3, 6, 7, and 10. These questions were selected based on good validity, representing indicators of adaptive reasoning comprehension ability, differentiating power, and difficulty level.

Furthermore, the population used in this study was the entire 5th-grade students at one of the schools located in South Tangerang, with a total of 105, and the sample used in classes 5B and 5C totaled 41 students. Sampling in this study uses nonprobability sampling through purposive sampling techniques. According to (Sugiyono, 2021) The purposive sampling technique is a sampling technique based on specific considerations. This study was analyzed using an Independent sample t-test to determine whether there was a significant difference between the average values of two groups of samples that had no relationship. The calculation in the data analysis test uses SPSS version 22 software to test N-Gain, normality, and Independent sample t-test.

RESULTS AND DISCUSSION

Based on the research data obtained through pre-test and post-test, the average results of adaptive reasoning ability are obtained in Table 2.

Table 3. Average Pre-Test, Post-Test, and N-Gain Adaptive Reasoning Ability Scores

Class	Mean Pre-test	Mean Post-Test	Mean Score N-Gain	Information
Experiment	39.43	69.57	0.47	Moderate
Control	38.05	56.40	0.26	Low

According to Table 2, the experimental class's average adaptive reasoning ability score was 39.43 for the pre-test and 69.75 for the post-test, with an N-Gain score of 0.47 interpreted as moderate. Meanwhile, in the control class, the average pre-test score was 38.05, and the post-test was 56.40, with an N-Gain of 0.26 interpreted as low. In this study, the data were usually and homogeneously distributed in the experimental and control classes, so the T-Test could be carried out to see if there was a difference between the two classes.

Tabel 4. Independent T Test Adaptive Reasoning Ability Test

N-Gain Score	Levene's Test for Equality of Variances		t-test for Equality of Means			Hipotesis	Keputusan
	F	Sig.	t	df	Sig. (2-tailed)		
Equal variances assumed	1.107	0.299	2.666	39	0.011	H_0 Rejected	There is a difference
Equal variances are not assumed.			2.686	36.782	0.011		

Based on Table 3. obtained a count score of 2.666, which can be interpreted as more remarkable than the table score of 2.022 with a data significance level of 0.01 < 0.05. Based on the decision-making standard, it shows that H_0 is rejected. Therefore, it can be concluded that there is a statistically significant difference between the two groups tested. According to this statement, there is a difference in the adaptive reasoning ability of students who learn to use the PBL model and those who learn to use the expository model. The previous statement shows that the PBL learning model is essential in improving students' adaptive reasoning skills. For this, it is the same as the statement (Kotto et al., 2022) which outlines that learning to apply the PBL model can stimulate learners to improve their reasoning skills. This condition occurs because the PBL model ensures students think above their abilities and use mathematical thinking skills to find solutions. Students play a responsive role, think critically and independently applying the PBL model, and foster students' courage in expressing their opinions.

Padmavathy and Mareesh (Oktaviana & Haryadi, 2020b) stated that PBL is an education that provides opportunities for students to hone their critical thinking skills, play an active role in ongoing learning, participate in discussions, and provide motivation in group learning. Therefore, the PBL model can increase adaptive reasoning ability. This statement is in line with research carried out by (Alfiah et al., 2021), which stated that after applying the PBL model, the experimental class showed an increase in the percentage from pretest to posttest by 22.2%. In comparison, the increase experienced in the control class was only 15.8% of the KKM. Based on this, it can be concluded that applying the PBL model can increase students' reasoning.

Furthermore, if further analysis is made based on the results of adaptive reasoning ability indicators in both the experimental and control classes, the results can be seen in Table 4.

Table 5. Results of Differential Results Per Indicator of Experimental & Control Classes

Experimental and control classes	Indicator				
	Formulating Allegations	Giving Reasons	Interesting Conclusion	Testing Arguments	Finding Patterns
Difference	0,24	0,18	0,45	-0,02	0,26

The difference between the results from each indicator based on Table 4.5 shows that the indicator, in conclusion, is a vast difference between the control class and the experiment. The ability to conclude is an effort to define or explain something that has been observed and based on previous understanding and knowledge in a short, clear, and accurate way. (Rahmayani & Fadly, 2022). The PBL model effectively supports the development of student's ability to draw logical and evidence-based conclusions; this is one of the critical indicators of adaptive reasoning skills. The ability to conclude is related to the PBL model. In the PBL syntax of the orientation stage, students begin with problems that must be solved, and students can improve critical thinking and problem-solving skills during this stage and analyze further to conclude. The next step is to organize students' learning; this process can help students identify information needed when drawing valid conclusions. The next step is supervising the group investigation; at this stage, students can exchange the information they have with their group mates, and the information that has been collected can be used to conclude when solving a problem. The application of group learning can help students hone critical thinking skills on a problem and can discuss or argue with their classmates to solve complex problems. Like the research conducted by Usman (Widiastuti & Kania, 2021), The discussion method encourages students to learn and think critically and express their opinions clearly and objectively when solving a problem.

Furthermore, according to Wulandari (Alfiah et al., 2021), The learning process that applies the PBL model is related to mathematical reasoning skills. This is because, in the main activities of PBL, participants have great potential to use their reasoning skills, including the ability to conclude. Based on the previous statement, the PBL syntax with the ability to conclude one of the indicators of adaptive reasoning ability is closely related. Students are trained to conclude by combining the information obtained to solve the problem. Therefore, the ability to conclude is interrelated with the syntax of the PBL model.

The success of PBL in improving adaptive reasoning is highly dependent on the strength of the context used. Contexts close to students' lives can help students transfer knowledge from the classroom to the real world, which is at the heart of adaptive reasoning. Texts that contain local wisdom can also make learning more meaningful, but also strengthen students' ability to think flexibly, critically, and ethically. This is an important foundation in shaping learners who are resilient and relevant to the challenges of the times. The implication of this is that teachers need to design an authentic, relevant, and meaningful learning context.

CONCLUSION

Based on the results of the difference between the pre-test and post-test in the two classes that have been tested, it is evident that the experimental group showed a difference of 30.32, while the control group showed a difference of 18.35. This indicates a higher adaptive reasoning ability among students in the experimental class. Furthermore, the independent t-test yielded a count score 2.666, which is statistically more significant than the table score of 2.022 at a data significance level of 0.01 < 0.05. As per the decision-making standard, H_0 is decisively rejected, concluding that there is a statistically significant difference between the two groups tested. Students can be trained in critical thinking by applying the PBL learning model. They are also allowed to play an active role and be more courageous in expressing their opinions during the learning process. When learning in groups, students can exchange ideas with their group mates to communicate more comfortably, and getting information to solve problems is more manageable. Therefore, using the PBL model improves students' adaptive reasoning skills, and implementing PBL makes students accustomed to developing their reasoning.

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