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Analysis of Problem Solving Capabilities in Problem Based Learning Contextual Approaches Based on Metacognitive Awareness

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Abstract

The purpose of this study is to test the effectiveness of PBL contextual approaches to problem solving abilities, analyze the problem solving abilities that are subjected to PBL contextual approaches based on metacognitive awareness. The research method used is mixed methods with a concurrent embedded model. The population in this study were students of class VIII SMP N 1 Mejobo Kudus in the 2018/2019 school year. Data collection uses documentation, questionnaires, test results and interviews. Using the cluster random sampling technique, one experimental class and one control class were obtained. The results showed that PBL learning was an effective contextual approach to students' problem solving abilities. Students with high, moderate and low metacognitive awareness experience the same mathematical problem solving abilities. Students with high metacognitive awareness after learning are able to master all stages of problem solving. Students with metacognitive awareness are able to master the stage of understanding the problem and implementing the plan while the stage of making plans and checking back tends to be able. Students with low metacognitive awareness before learning are less able in all stages of improvement. After learning to be able to understand the problem, tend to be able to carry out plans, make plans and check again.

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INTRODUCTION

Mathematics as a basic science that is learned at every level of education has a function that is as a tool, mindset, and science. According to Khan (2012) states that "mathematics is a subject that demands conceptual knowledge, the relationship between existing knowledge and prior knowledge. Mathematics plays an important role in shaping critical thinking skills, logical, creative, and able to work together. Therefore learning in class must consider students' mathematical thinking ability as the main goal to be achieved. The implication of students need to have mastery of mathematics at a certain level, which is the mastery of mathematical skills that can understand the world and succeed in his career.

Teachers must pay a lot of attention, not only focused on student learning outcomes, but also on thinking skills, reasoning, and students' problem solving abilities using mathematics. The teacher must view mathematics as an active, dynamic, generative, and explorative process. Mathematical processes about reasoning and high-level mathematical thinking as processes of mathematical problem solving, mathematical communication, mathematical reasoning, and mathematical connections (NCTM, 2010)

It can be seen that mathematics cannot be separated from problem solving. Jarret, 2000 asserted that "Problem solving is the heart of mathematics" which means the heart of mathematics is problem solving.

Many countries have placed problem solving as the spirit of mathematics learning. For example, the ability of students in problem solving is central in teaching mathematics in Singapore (Kaur, 2013). This is also supported by Rickard (2005) who states that problem solving is one of the main focuses in mathematics education since 20 years ago.

The ability to solve problems as one of the important aspects in making students experts in mathematics (Fischer, Samuel, and Joachim, 2012; Lestari, Dwijanto, and Hendikawati, 2015). Mathematical problem-solving skills are needed by students (Novotná et al, 2014; Fischer, Samuel, and Joachim, 2012). According to Lestari, Dwijanto, Hendikawati (2015) states that problem-solving skills are not only needed to solve problems in mathematics, but students are also needed to solve problems they experience in everyday life.

This important problem solving role causes problem solving to become a focus in mathematics learning in several countries (Sugiman and Kusumah, 2010). Therefore, the mathematics teacher is obliged to equip students with the ability to solve problems. In line with this, the revised edition of the 2013 curriculum puts the ability to solve mathematical problem solving as an ability aimed at almost every Core Competency at all levels of the education unit (elementary, junior high, and high school). The implication of that, while learning mathematics should be trained students to solve mathematical problems. However, learning mathematical problem solving in schools still faces many obstacles.

One obstacle experienced is difficulty in understanding and solving problem solving problems. This is shown based on the data of the results of 34 problem-solving test trials for grade VIII students at SMP Negeri 1 Mejobo Kudus.

The observations of 34 students, only 10 students were able to interpret correctly. Of the 10 students who were able to interpret correctly, 4 students were able to use the concept of the surface area of the beam to calculate the area of the building to be painted. Of the 4 students who were able to count correctly, only one student was able to give the final answer correctly according to the provisions in the problem. The other three children haven't paid close attention. These difficulties can be seen at the stage of writing a plan and checking answers.

Another obstacle experienced is from the side of a teacher in applying appropriate learning models to develop problem solving skills. The learning model that gives students the opportunity to develop their maximum potential, especially in terms of problem solving ability, is the PBL model. PBL model is a learning model that is designed to solve the problems presented.

The implementation of PBL learning is detailed by Sudarman (2007) as follows: 1) learner orientation to the problem; 2) organizing students to learn; 3) guiding individual and group investigations; 4) develop and present the work; 5) analyze and evaluate the problem solving process.

Mathematical problems are related to the real world and the context of mathematics itself. For this reason, an approach is needed to connect mathematical problems related to the real world and the context of mathematics itself. One way is to use a contextual approach as the beginning of formal mathematics teaching in accordance with the level of development of students who are at a concrete operational stage.

Contextual approach (Contextual Teaching and Learning) is a learning concept that helps teachers link material taught with real-world situations to students and encourages students to make connections between the knowledge they have by applying it in their daily lives as family and community members (Rusman, 2011). The contextual approach can be operationalized with PBL so as to create a learning model that can improve students 'problem solving abilities in accordance with students' daily lives.

The process of learning mathematics will take place well if there is awareness of students. Awareness of students or commonly called metacognitive awareness. Metacognitive awareness also influences one's learning process. Anggo (2011) states that metacognitive awareness is an awareness of cognition, and the regulation of one's cognition that plays an important role especially in improving learning and problem solving abilities. Individuals with high metacognitive awareness have better planning, information management, monitoring and evaluation compared to individuals with moderate metacognitive awareness and individuals with metacognitive awareness are having better planning, information management, monitoring and evaluation compared to individuals with metacognitive awareness low. Students with low awareness of metacognitive awareness become an indication of lack of self-confidence and independence in solving problems.

Based on the results of the trial of the VIII metacognitive awareness questionnaire for SMP Negeri 1 Mejobo Kudus students showed that 59% of 34 students were still in the low metacognitive awareness category. In line with the problem solving ability test, students who are in low metacognitive awareness, in problem solving tests get low scores too. This reinforces the opinion that the learning process requires metacognitive awareness in solving mathematical problems.

This study aims to look at the impact of PBL models on the contextual approach in students 'mathematical problem solving abilities and analyze mathematical problem solving abilities based on students' metacognitive awareness on the problem based learning model of contextual approaches.

Practically this research is expected to provide benefits as a reference material or input to teachers to design learning designs in accordance with students' metacognitive awareness and provide references and input for schools in efforts to improve learning so that the quality of learning can improve.

METHODS

The study was conducted at SMP Negeri 1 Mejobo Kudus. Using the cluster random sampling technique, one experimental class and one control class were chosen. Experimental class as a class that gets PBL contextual approach and control class as a class that gets PBL.

The research method used in this study is a mixed method with a concurrent embedded model. The concurrent embedded model combination research method is a research method that combines quantitative and qualitative research methods by mixing the two methods unbalanced (Sugiyono, 2013). The imbalance included by placing qualitative research methods as primary methods and quantitative research methods as secondary / support methods.

Before conducting research, research instruments and instruments are prepared. The tools prepared are in the form of syllabus, lesson plans (lesson plans), and learning media. The research instruments were pre-test and post-test of metacognitive awareness questionnaire, set of pre-test and post-test mathematical problem-solving abilities Each learning device was validated by experts with a scale rating of 0 as the lowest value and 4 as the highest value for each learning device. The score of each item is calculated on average. The research instrument was validated by an expert with a scoring technique and the same criteria as the validation of the research tools. Specifically for the Pretest and Posttest tests a non-experimental class and a control class are then tested for reliability, validity, differentiation, and difficulty levels.

Data collection techniques used in this study were test, questionnaire and interview techniques. The test techniques are in the form of mathematical problem-solving ability, post-test mathematical problem-solving ability, metacognitive awareness questionnaire and interview. The metacognitive awareness questionnaire was given to the experimental class before learning and after learning. The metacognitive awareness questionnaire given to the experimental class before learning is used to classify students who have high, moderate and low metacognitive awareness, while the metacognitive awareness questionnaire given to the experimental class after learning is used to see whether there is an increase in students' metacognitive awareness before and after learning . Pretest and posttest mathematical problem solving abilities are given to the experimental and control classes before learning (pretest) and after learning (posttest).

Quantitative and qualitative data were collected and then analyzed according to the concurrent embedded model research combination method. Qualitative data as primary / primary data and quantitative data as supporting / secondary data. Analysis of the data in this study uses the Miles and Huberman Model which includes: (1) data reduction, (2) data display, (3) conclusion / verification. Using cluster random sampling technique, class VIII D was chosen as the experimental class and VIII A as the control class. The experimental class is a class that uses the PBL model contextual approach and the control class is a class that uses the PBL model.

Analysis of the results of the study aims to prove the research hypotheses. Analysis of the results of the study includes quantitative and qualitative analysis. Quantitative analysis aims to prove empirically the effectiveness of PBL in contextual approaches to mathematical problem solving abilities. The effectiveness of PBL contextual approach is shown by 1) Achieving minimal completeness criteria, 2) Increasing mathematical problem solving abilities, 3) Comparison of control classes with experimental classes.

RESULTS AND DISCUSSION

The problem solving ability test shows the following results:

Table 1. Ability to Solve Mathematical Problem Pretest and Posttest.

No	Source of variation	PBL approach contextual		PBL
		Pretest	Posttest	Posttest
1	Many Student	34	34	34
2	Average	57.91	75.37	69.67
3	SD	8.43	7.45	8.45
4	Maximum	43.75	56.25	46.88
5	Minimum	78.13	90.63	84.38

PSS 16 obtained sig values. (tailed) = 4,204. Because the value of sig. (tailed) is more than α then H_0 is accepted. H_0 is accepted meaning 75% of the average class with PBL contextual approach is more than or equal to 70. This proves that the class with PBL contextual approach reaches the completeness criteria.

The second part is statistically proven difference in mathematical problem solving abilities before and after PBL treatment contextual approach. The statistics used are paired-samples t-test. The data used are pretest and posttest mathematical problem solving abilities.

Hypothesis

H_o: μ1 = μ2 (the average mathematical problem solving ability before and after is the same)

H_a: μ1 ≠ μ2 (the average mathematical problem solving ability before and after is different)

With α = 0.05 and test statistics with One-sample t-test two parties assisted by SPSS 16 obtained the following results

Paired Samples Test		t	df	Sig. (2-tailed)
Pair 1	Pretest - Posttest	-12.73	33	0.000

Obtained sig. (2-tailed) = 0,000. Because the value of sig. (tailed) is less than α then H_0 is rejected. H_0 is rejected, it means that H_a is accepted, it means that the average mathematical problem solving ability before and after learning is different. By looking at Table 1 the average value of mathematical problem solving ability after learning 75.37 is higher than the average mathematical problem solving ability before learning 57.91. This shows that the ability to solve mathematical problems after getting PBL treatment is better contextual approach.

The third part is statistically proven to compare the average value of the class that receives PBL treatment with a contextual approach with the class that gets PBL treatment only. The data used is the data post-test the final mathematical problem solving ability of the two classes. The normality and homogeneity test shows that the data is normally distributed and not homogeneous so an independent statistical sample t-test is used. The statistical independence test sample t-test was used to determine the difference in the average value of students' mathematical problem solving abilities of the two groups.

Hypothesis

H_o: μ1 = μ2 (the average of the two samples is the same)

H_a: μ1 ≠ μ2 (average of the two samples is different)

With α = 0.05 and test statistics with the One-sample T test two parties assisted by SPSS 16 obtained the following results

		Levene's Test for Equalty of Varilances				
		F	Sig	t	df	Sig. (2-tailed)
Value	Equal variances assumed	0.433	0.513	2.95	66	0.004
	Equal variances not assumed			2.95	64.986	0.004

Obtained sig. (tailed) = 0.004. Because the value of sig. (tailed) is less than α then H_0 is rejected. If H_0 is rejected then H_a is accepted, it means that the average class with PBL is a contextual approach and the class with PBL learning is different. Because the two averages are different, further tests are needed. By looking at table 1 shows the average grade with PBL contextual approach 75.37 higher than PBL learning alone 69.67. This shows that the ability to solve mathematical problems in classes that get PBL treatment contextual approaches are better than classes that get PBL treatment only. It was concluded that the PBL model contextual approach was better than PBL alone.

The fourth part is statistically proven to be a comparison of the value of the gain / increase in the ability to solve mathematical problem classes that get PBL treatment with a contextual approach to classes that get PBL treatment only. The data used are pretest and posttest data for the final mathematical problem solving ability of the two classes. With SPSS 16, the data are normally distributed (sig. 0.044) and not homogeneous (sig. 0.03) so that the independent sample t-test statistical test is used.

Table 2. PBL Class Gain Value Contextual Approach and PBL Class

No	Source of Variation	PBL contextual approach	PBL
1	Many Student	34	34
2	Average	0.42	0.29
3	SD	0.15	0.17
4	Maximum	0.75	0.63
5	Minimum	0.08	0.06

Hypothesis

H_o: $\mu1 = \mu2$ (the average of the two samples is the same)

H_a: $\mu1 \neq \mu2$ (average of the two samples is different)

With α = 0.05 and the independent test statistical test t-test two parties assisted by SPSS 16 obtained the following results

		Levene's Test for Equalty of Varilances				
		F	Sig	t	df	Sig. (2-tailed)
Value	Equal variances assumed	1.224	0.273	3.005	66	0.004
	Equal variances not assumed			3.005	65.7	0.004

From the output data the value of sig is obtained. (2-tailed) = 0.004. Because the value of sig. (tailed) is less than α then H_0 is rejected. If H_0 is rejected then H_a is accepted, it means that the average value of class gain with PBL is contextual approach and class with PBL learning is different. Because the average gain values of the two are different, further tests are needed. By looking at table 2 shows the average grade gain value with PBL contextual approach 0.42 higher than PBL learning alone 0.29. This shows that increasing the ability to solve mathematical mathematical problems in classes that get PBL treatment contextual approach is better than classes that get PBL treatment only.

PBL models are effective contextual approaches to students' problem solving abilities. This is because (1) students' presentations with PBL contextual approaches that have reached completeness criteria (2) mathematical problem-solving abilities after receiving PBL treatment contextual approaches are better; and (3) improvement in mathematical mathematical problem solving skills in classes that get PBL treatment contextual approaches better than classes that get PBL treatment. This is in line with the study of Maretasani and Dwijanto (2017) which states that the PBL model is effective for improving students' mathematical problem solving abilities.

Some experts also state that PBL can be used as an alternative in innovative mathematics learning. Simorangkir (2014) in his research stated that PBL which emphasizes the ability to solve mathematical problems is very well applied so that PBL can be used as an alternative in innovative mathematics learning.

Analysis of problem solving abilities includes the stage of understanding the problem, making plans, carrying out plans, and checking again. After analyzing students' problem solving abilities for each category of metacognitive awareness, a summary of problem solving abilities with different levels of problem solving ability is available for each category of metacognitive awareness. Following is a description of students' mathematical problem solving abilities based on metacognitive awareness.

In the stage of understanding the problem before PBL the contextual approach of students with high metacognitive awareness is able to understand the problem well. Students with metacognitive awareness are being able to understand all the words in the problem, but have not been able to explain the problem again in their own sentences, know what is known, know what is asked, the information provided is sufficient. While students with low metacognitive awareness are able to understand all the words in the problem, have not been able to explain the problem in their own sentences, do not know what is known, do not know what is asked, the information provided is still lacking.

After PBL contextual approach at the stage of understanding the problem of students with high, medium, or low metacognitive awareness, able to understand all the words that are in the problem, explain the problem in their own sentences, know what is known, know what is asked, information provided has enough. Students are able to understand the problem well because in learning using the PBL model contextual approach, the teacher provides scaffolding periodically to each group. According to Vygotsky, scaffolding is a guidance given by a teacher to students in the learning process with focused issues. At the first meeting the teacher gives full scaffolding at the stage of understanding the problem, and reduces the scaffolding at subsequent meetings regularly. So that at the stage of understanding the problem, students are able to understand the problem well.

In the stage of making plans before PBL the contextual approach of students with high metacognitive awareness tends to plan well. Students with moderate and low metacognitive awareness are less able to make plans. This is in line with the opinion according to White (2005) students who are able to understand what is desired about the problem is not necessarily able to identify the patterns / operations needed to solve the problem. This situation is in accordance with the results of Sari & Wijaya's research (2017) that many students find it difficult to analyze the facts that exist in the problem to be associated with relevant mathematical concepts so that students incorrectly transform problems in mathematical models. Students with high metacognitive awareness and moderate tend to meet the indicators to make a plan that is drawing pictures. Whereas students with low metacognitive awareness are less able to draw pictures. Next indicator for making a plan is to find a formula. Students with high metacognitive awareness tend to be able to find formulas to solve problems. While students with moderate and low metacognitive awareness, are less able to find formulas. The indicator to make the next plan is to identify the sub-objectives, students with high metacognitive awareness and moderate tend to be able to identify the sub-objectives. Whereas students with low metacognitive awareness are not able to identify sub-goals. Students with high metacognitive awareness are able to identify sub-goals by using formulas and drawing pictures. Whereas students with metacognitive awareness are being able to identify sub-objectives only by drawing pictures. This result is supported by the statement of Noor & Mulyono (2016) that the ability to plan learning strategies and targets to be achieved in learning is one of the characteristics of students who have metacognitive awareness.

In the stage of making plans after PBL the contextual approach of students with high metacognitive awareness has increased which initially tends to be able to plan well. Students with moderate and low metacognitive awareness who were initially incapable of being inclined to plan well. Students with high metacognitive awareness and are able to meet the indicators to make a plan that is drawing pictures. Whereas students with low metacognitive awareness tend to be able to draw pictures. Next indicator for making a plan is to find a formula. Students with high metacognitive awareness and are able to find formulas to solve problems. Whereas students with low metacognitive awareness tend to be able to look for formulas. Indicators of making the next plan are identifying sub-objectives, students with high metacognitive awareness and being able to identify sub-goals. Whereas students with low metacognitive awareness tend to be able to identify sub-goals. Students with high metacognitive awareness and are able to identify sub-goals using formulas and drawing pictures. Whereas students with low metacognitive awareness are able to identify sub-objectives only by drawing pictures.

At the stage of implementing a problem solving plan before PBL a contextual approach, only students with high metacognitive awareness are able to implement the strategy or choose a strategy until the problem is solved. While students with moderate metacognitive awareness tend to be able to implement strategies or choose strategies until the problem is solved. That is because students with metacognitive awareness are not careful enough in working on the problems. This situation is in accordance with White's statement (2005) that is very likely to occur in students who are able to identify operations or patterns of operations on the problem, but are unable to complete the operation appropriately. Students with low metacognitive awareness are less able to implement strategies or choose strategies until the problem is solved. That is because students with low metacognitive awareness cheating during the test. This is supported by research by Pujiati (2010) and Widiyastuti (2012) which shows that some students who do not yet have an optimal metacognitive awareness show behavior coming to school late, not completing school tasks, cheating on tests, not utilizing library facilities, the minimum criteria of mastery learning value is incomplete.

At the stage of implementing a problem solving plan after PBL a contextual approach, students with high metacognitive awareness and are able to implement a strategy or choose a strategy until the problem is solved. Whereas students with low metacognitive awareness tend to be able to implement strategies or choose strategies until the problem is solved. Students with low metacognitive awareness do not cheat again during the test.

In the re-checking stage before the PBL contextual approach, only students with high metacognitive awareness tend to be able to check all the information and calculations involved. Students with high metacognitive awareness, have a high enough confidence in the results of their work. While students with metacognitive awareness are less able to check back. Students with metacognitive awareness are being less able to check all the information and calculations involved. In the column provided to check again, students with moderate metacognitive awareness, tend to copy the calculations from the stage of carrying out the plan. Furthermore students with low metacognitive awareness are less able to check back. That is because at the stage of re-checking, students with low metacognitive awareness of cheating the work of their friends. This is in line with the research of Husna, Veronica and Kurniasih (2019) that low metacognitive awareness needs to get special attention at the stage of making plans, implementing plans, and checking again. Furthermore, students with metacognitive awareness are in need of special attention at the stage of making plans and rechecking.

In the re-checking stage after PBL a contextual approach, students with high metacognitive awareness are able to check all the information and calculations involved. Students with high metacognitive awareness, have high confidence in the results of their work. Whereas students with moderate and low metacognitive awareness tend to be able to check again. Students with moderate and low metacognitive awareness tend to be able to check all the information and calculations involved.

CONCLUSION

Based on the results of research and discussions that have been conducted by researchers, it is concluded that the students' mathematical problem solving abilities with PBL models contextual approaches have proven to be effective.

Analysis of mathematical problem solving abilities with PBL models contextual approach based on students' metacognitive awareness. Research subjects with high metacognitive awareness before learning tend to be able to make plans and check again after learning is able to master it.

Likewise with research subjects with moderate metacognitive awareness who before learning tend to be able to meet the indicators of understanding the problem, unable to meet the indicators to make plans, tend to be able to carry out plans, less able to check again after learning there is an increase. Changes that occur in research subjects with moderate metacognitive awareness that is able to meet indicators understand the problem and implement the plan, tend to be able to meet the indicators to make plans and check again.

Research subjects with low metacognitive awareness before learning tend to be able to meet indicators understanding the problem, less able to make plans, carry out plans and recheck. After learning is done there is an increase in being able to understand the problem, tend to be able to make plans, implement plans and check again.

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