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Improving Problem-Solving Ability through a Constructivist Approach in Learning Mathematics for Grade X High School Students

Nasrianus Nampung[1], Aloisius Loka Son[2*], Ferdinandus Mone[3],
[1, 2, 3)] Mathematics Education Program, universitas Timor, Indonesia
*aloisiuslokason@unimor.ac.id.

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Abstract
This study aims to improve students' problem-solving abilities through a constructivist approach. This studi uses quantitative methods in the form of pre-experimental. This research was carried out in the even semester of the 2022/2023 academic year This research design used one group pretest and post test. The participants of this study were 17 grade X students of one of the high schools in North Central Timor district. Research instruments in the form of problem-solving ability tests. Before conducting data analysis, a prerequisite test is first carried out, namely a normality test using the SPSS-assisted Shapiro wilk test and the results obtained that the data is normally distributed. Test the hypothesis using a one-sample t-test and a paired sample t-test. The results showed that, students who learned using the constructivist approach achieved minimal completeness and there was an increase in the mathematical problem-solving ability of students who learned through the constructivism approach. Learning with a constructivist approach can facilitate the problem-solving ability of high school students. Therefore, recommended to advanced researchers in order to be able to apply constructivist approaches to other mathematical abilities

Keywords: Constructivist Approach, Problem-Solving Ability

1. INTRODUCTION

The ability to solve problems is the first step needed in every advancement in the world of education because in the 21st century, there is a change in the structure of learning, it encourages an educator to be more creative in dealing with existing technological developments. Mathematical knowledge can also be more meaningful to students if they are guided to connect facts and concepts and relate learning to knowledge that is often applied in everyday life. Students' problem-solving abilities have

*Corresponding author, aloisiuslokason@unimor.ac.id

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the characteristics of openness to new experiences, flexibility in thinking, freedom of expression, respect for fantasy, interest in creative activities, belief in individual ideas in giving consideration.

Problem-solving ability is a creativity that should be developed in dealing with various life problems. One of the things prepared by teachers in teaching is the learning approach used. The use of the right learning approach will optimize the potential possessed by students as well as the achievement of learning competencies, otherwise if the use of learning approaches is not appropriate, then students cannot develop optimally and learning competencies are not fully achieved. Therefore, it is important to choose the right learning approach for classroom learning. Learning approaches that can be used by teachers vary, but currently there are still teacher-oriented learning approaches (Teacher Centered).

Based on the observations of researchers during Field Experience Practice, the mathematics learning process carried out is still teacher-centered and the obstacles faced are the lack of participant participation during the learning process. When given questions related to problems in everyday life, some students have not been able to solve the given problems. Students tend to be passive in expressing opinions so that there is no good interaction between educators and students. This is one of the challenges that must be found a solution. Another problem that occurs is that the average mathematics learning outcomes are still below the Minimum completeness criteria (MCC) score with the MCC obtained by students determined by the school, which is 70. The results of learning mathematics obtained by students are not optimal, because the tests achieved by students are very minimal. Many students have not reached the MCC score of ≥ 70. The data obtained that 40% of students' mathematics test scores were below the MCC score. In addition, students still consider mathematics as a difficult and boring subject. This obstacle certainly affects the value of MCC achieved by students.

Problem-solving is part of mathematics learning which is very important because in the learning process and its completion, students are allowed to gain experience using the knowledge they already have (Hadi and Radiyatul, 2014; Son & Fatima, 2020). Problem-solving is the process of solving problems in a row.

So problem-solving is an important, even the most important part of learning mathematics. Because basically one of the goals of learning mathematics for students is to have the skill in solving mathematical problems or problems, as a means to hone careful, logical, critical, analytical, and creative reasoning. Thus, problem-solving ability in mathematics become the focus of mathematics learning at all levels, from elementary school to college. By learning problem-solving in mathematics, each student will gain ways of thinking, diligent habits, and curiosity, as well as confidence in unusual situations, as well as situations they face outside the mathematics classroom. In everyday life and the world of work, being a good problem solver can bring great benefits.

Observing this reality, it is necessary to change the learning approach that is more meaningful so that the learning process wants to prioritize active student involvement to find their own knowledge through interaction and the teacher acts as a motivator in optimizing student learning. Teachers should provide opportunities for students to learn as widely as possible and build their own knowledge. One of the efforts that can be used to overcome these problems is that teachers carry out learning with a constructivist approach.

To overcome these problems, learning innovations are needed in order to improve students' mathematical problem-solving ability (Son, Sudirman & Widodo, 2020). One approach to learning that can facilitate students' mathematical problem-solving ability is the constructivist approach. Constructivism views that knowledge is a construction (formation) of people who know a (schematic). Galserfeld (in Sudrajat, 2008) suggests that there are several abilities needed in the process of constructing knowledge, namely (1) the ability to remember and reexpress experiences, (2) the ability

to compare and make decisions about similarities and differences, and (3) the ability to prefer one experience over another. In learning mathematics with a constructivist approach, students construct their own knowledge in their minds both individually and with friends (discussion), in an effort to develop their reasoning abilities, as stated by Wallace, Engel and Mooney (in Asra and Sumiati, 2007), that cognitive learning theory has a postulate "for the development of learning reasoning must be in the form of group discussions". In constructivist learning, students construct knowledge through group discussions so that they will be able to improve students' reasoning skills and mathematical achievement. This is contrary to the learning process applied by the teacher, which is transferring their knowledge to students or students only receive ready-made knowledge from their teachers, so that learning like this is less able to improve students' reasoning abilities.

Constructivism is the cornerstone of contextual thinking, where knowledge is built by humans little by little, the results of which are expanded through limited contexts. Knowledge is not a set of facts, concepts or rules that are ready to be picked up and remembered. Humans must construct that knowledge and give meaning through real experience (Rosiyanti, 2015). The constructivist approach is an approach whose implementation positions students as individuals who actively construct their own knowledge derived from their experiences (Sahrudin, 2014). The learning paradigm of learning constructivism must be able to measure three aspects, namely Cognitive, Affective, and Psychomotor (Izabel, Souza, and Torres, 2015; Naomee and Tithi, 2013). To achieve these three aspects, learning activities in class are not enough just to use the lecture method, because the teacher only provides material theoretically and makes students not actively involved in learning. According to the constructivist view, applied learning must be centered on building students' knowledge independently. Student-centered learning makes these students think independently so as to provide opportunities for students to understand concepts optimally, the same in learning because the characteristics of students vary, there are students who are diligent and active during learning and there are also students who are not active (passive) during learning, this will make it difficult for teachers to motivate students to be active in learning.

This research, reinforced by previous research by Riyanto (2009) found that one of the learning objectives using a constructivist approach is to develop students' ability to become independent or creative thinkers. Continued Slavin (Trinanto: 2014) suggests that the constructivist approach in learning is based on the theory that students will find and understand difficult concepts more easily if they can discuss these problems with their friends.

In this study, researchers used worksheets that contained problems in everyday life related to the main material of trigonometric comparisons. The worksheets designed describe the characteristics of constructivism and are used as media in the learning process. So, the application of the constructivist approach can be seen from the LKS used, as well as the implementation process which applies the principles and characteristics of the constructivist approach. This implementation process is carried out with the aim of improving the problem-solving abilities of students who learn through a constructivist approach.

2. METHOD

The approach used in this study is quantitative research. Quantitative research is defined Sugiyono (2016) as a method with research data in the form of numbers and analyzed using statistics. In this study, the type of research used was pre-experimental research, namely experimental research conducted only in one group called the experimental group and no comparison group or control group was held (Sugiyono, 2016).

The research design used in this study was to use a one group pre-test-post test design that was randomly selected and no tests were carried out for stability and clarity of group conditions before being treated. Research design one group pretest and posttest design was measured using pretest conducted before treatment and post test conducted after treatment (Sugiyono, 2017).

One group pretest and posttest design research designs can be appointed based on the following scheme:

Table 1. Research design one group pre test and post test design

Pretest	Treatment	Posttest
T_1	X	T_2

Source: (Sugiyono, 2017)

Description:

T_1: Pre-test is carried out before treatment is given

X : Treatment is given to students using the Constructivism approach

T_2 : Post-test is carried out after treatment is given

The population and sample in this study are grade X students. The research sample is determined based on a saturated sample technique where all members of the population are sampled. The data analysis technique used is to use a one sample t-test with equations:

$$t_{Count} = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}} \quad (1)$$

But in this study, it will be analyzed using SPSS application version 20. The T-test above is used to test the completeness of students' problem-solving abilities. Test the comparison of mathematical problem-solving ability before and after student learning using post-test/pre-test data. The improvement comparison test uses paired samples t-test data obtained through the equation:

$$t_{Count} = \frac{\bar{D}}{\left(\frac{SD}{\sqrt{N}}\right)} \quad (2)$$

The hypotheses tested in this study are respectively completeness and comparison The problem-solving ability of students who learn through a constructivist approach is better than students who learn before. Before testing these two hypotheses, normality of completeness and comparison data is first tested as a condition for using parametric statistics. Both prerequisite tests and hypothesis tests are carried out using the help of the SPSS application version 20.

The results of the normality test are used to see if the distributed data is normal or abnormal. This study is for normality test results using Shapiro-wilk. Data is said to be normally distributed (symmetric) in the Shapiro-wilk test if the signification value is greater than 0.05.

3. RESULTS AND DISCUSSION

This research data is in the form of completeness data (posttest/pretest) and comparison of students' mathematical problem-solving abilities. Therefore, in this section, the results of research and discussion of each are described as follows.

a. Due diligence of students' problem-solving abilities

Before conducting a hypothesis test, a normality test is first carried out. The normality test results can be seen in Table 2.

Table 2 Data normality test results

Troubleshooting Capabilities	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
post test	,134	17	.200*	,932	17	,234
pre test	,181	17	,143	,948	17	,421

Table 2 shows that the posttest data and experimental class pre-test data have a significance of $> \mathbf{0.05}$, so it is stated that the problem-solving ability data of the students of the class are normally distributed.

This distribution of normal data allows testing his hypothesis using parametric t-test statistics. The results of the due diligence of students' problem-solving abilities can be seen in Table 3.

Table 3 One-sample t-test

Test Value = 70					
				95% Confidence Interval of the Difference	
T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
17,557	16	,000	71,64706	62,9959	80,2982

Student problem-solving completeness data is used to test whether the ability with constructivist learning is statistically complete or not.

Based on the output of one sample t test table 3, it is known that the value of students' problem-solving ability is $t_{hitung} > t_{tabel}$ (17,557 > 1,746), so can be concluded that the constructivist approach has a completeness in improving problem-solving ability in mathematics learning for middle school students in grade X students.

The completeness of the problem-solving ability of students who learn through a constructivist approach is greater than that of previous students. This is influenced by several reasons including mathematics learning with a constructivist approach that really helps students in learning because in learning students are more enthusiastic and interact with their group mates. Researchers learn using a constructivist approach, namely by applying the characteristics of a constructivist approach, one of which is active learning, authentic and situational, interesting and challenging, linking old knowledge with new information, reflecting on knowledge and teachers can provide assistance in the learning process.

Learning with a constructivist approach students seem to be more active in learning and working together with their group mates, so that in the teaching and learning process students are easier to understand. According to Karli and Magaretah (2002: 16) stated that constructivism model learning is a learning process that begins with cognitive conflict, which in the end knowledge will be built by students themselves through experience and the results of interaction with their environment. The results of this study are reinforced by previous research conducted by (Jatisunda, 2017) in his research that there is a positive influence on the use of constructivism expression approach on learning on students' mathematical problem-solving abilities.

b. Comparative test of Mathematical Problem-Solving Ability Before and After Learning

The distribution of data on improving students' mathematical problem-solving abilities is normal, this allows testing their hypotheses using parametric statistics t-test. Descriptives of statistics students' mathematical problem-solving ability can be seen in Table 4.

Table 4. Descriptives statistic

	N	Range	Min.	Max.	Sum	Mean		Stdv.
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
post test	17	52,00	42,00	94,00	1218,00	71,6471	4,08093	16,82610
pre test	17	42,00	18,00	60,00	656,00	38,5882	3,45353	14,23929

The Descriptives statistic table shows the descriptive value of each variable in a paired sample. Based on the output results in table 4, it is obtained as follows:

1. Students' problem-solving ability in the posttest had an average score of 71.6471 from 17 data. The distribution of data (Std. Deviation) obtained is 16.82610 with Std. Error 4.08093.
2. Students' problem-solving ability in the pretest has an average score of 38.5882 from 17 data. The distribution of data (Std. Deviation) obtained is 14.23929 with Std. Error 3.45353.

This indicates a posttest score higher than a pretest score. However, the distribution range of Postest data is narrowing with lower error standards. That is, the data is less variable because the value of standard deviation and standard error is smaller than the mean value. The results of the comparative test for improving students' mathematical problem-solving skill can be seen in Table 5.

Table 5 Paired samples t-test

	Paired Differences					T	Df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1 post–pre	33,06	4,58	1,11	30,71	35,41	29,79	16	,00

The constructivist approach to the process of teaching and learning activities can make students easier to understand and in learning students become more enthusiastic about learning, this is because students interact with their group friends and students are naturally calm without having to be regulated.

The Constructivism approach is a learning that utilizes reality in the environment around students that is able to make students easily understand and expedite the process of learning mathematics, so as to improve the goals of mathematics education better. In student learning, based on table 5 about the t test above, shows a significant difference between students' mathematical problem-solving abilities before and after being given a constructivist approach. To see the value of t_{tabel} then based on degrees of freedom (df), a significant level of 5% is obtained $t_{table} = 2.120$. Based on the results of the t-test analysis, it can be obtained that the t_{count} is greater than t_{table} which is $29.791 > 2.120$

The paired samples output table also contains information about the value of mean paired differences is 33.05882. This value shows the difference between the average posttest learning outcomes and the average pretest learning outcomes or $(71.6471 - 38.5882 = 33.0589)$ and the difference between 30.70640 to 35.41125 (95% Confidence Interval of the difference lower and upper).

The results of data analysis improve the ability to solve learning math problems better than before. This is caused by several factors, one of which is when the learning process takes place using the Constructivism approach facilitates problem-solving ability because the learning process always begins with relevant problems around the student environment. Researchers in the learning process provide student worksheets, provide facilities needed by students, so that in learning students look very enthusiastic and enthusiastic in the learning process in class and students are easier to use the approach of repeating and remembering the learning material delivered. Vygotsky (Harahap, 2016) stated that the approach of learners in building a concept needs to pay attention to their social environment. The average posttest score of students' problem-solving ability in learning is better than the pre-test score. It can also be seen in the results of the analysis of statistical hypothesis calculations. This is caused by several factors, one of which is when the learning process takes place to train students to think critically and creatively with constructivism because learning with a mathematics education approach greatly facilitates students in learning mathematics to improve their learning, problem-solving ability because in the process it always starts or begins with context problems that exist around the student environment.

This is in line with previous research conducted by Harahap & Lubis (2019) which stated that there was an increase in the mathematical problem-solving ability of students who learned with a constructivist approach. Learning with a constructivist approach invites students to discuss and argue with their group friends so that students can solve math problems well in groups or individually. Learning with a constructivist approach greatly facilitates students in learning mathematics and students more easily understand the material so as to improve problem-solving ability. In line with the opinion (Trianto, 2010) which states "In the learning process of constructivism students build their own knowledge through active involvement in the learning and teaching process, students are the center of attention not teachers". Furthermore (Suprijono, 2009) stated that the mathematical problem-solving ability of students who follow learning with a constructivist approach requires the ability to remember and rediscover experiences, the ability to compare the ability to make decisions and the ability to prefer others. In learning with a constructivist approach, students give positive responses or responses.

4. CONCLUSION

The findings in this study are 1) the problem-solving ability of students taught with a constructivist approach has experienced the completeness of Minimum completeness criteria (MCC), and 2) the problem-solving ability of students who learn through a constructivist approach has increased. This finding shows that learning through a constructivist approach can facilitate the problem-solving ability of high school students. To advanced researchers, it is recommended that be able to apply the constructivist approach to other mathematical abilities.

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