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ADVOCACY APPROACH WITH OPEN-ENDED PROBLEMS TO MATHEMATICAL CREATIVE THINKING ABILITY

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ABSTRACT

The purpose of this study is to find out the increase in students' ability to think creatively in advocacy learning by using open-ended problems. This type of research is an experiment with nonequivalent control group design. The sample in this study were 72 students taken using random sampling techniques. The variables in this study are learning models, mathematical creative thinking abilities, and general mathematics abilities. The instruments used in this study were creative thinking tests and general mathematics tests. Data analysis techniques used in this study are statistical inference using the Mann-Whitney test and one-way ANOVA. The results showed that students who were treated with an advocacy approach by presenting open-ended problems improved their mathematical creative thinking abilities better when compared with conventional learning.

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1. INTRODUCTION

Creative thinking processes are rarely trained in the general education process (Ariandari, 2015; Susilo, 2012). The ability to think creatively is needed by students in solving mathematical problems (Asriningsih, 2014; Noer, 2011; Saefudin, 2012; Simbolon, Surya, & Syahputra, 2017; Siswono, 2005; Sumarmo, Hidayat, Zukarnaen, Hamidah, & Sariningsih, 2012). The results of previous studies indicate that the ability of students to understand problems and plan a solution is still very low (Pardimin, Widodo, & Purwaningsih, 2018; Siswono, 2005, 2010; Widodo, Darhim, & Ikhwanudin, 2018; Widodo, Turmudi, & Dahlan, 2019). Understanding a problem is shown by knowing what is known and what is asked (Pardimin & Widodo, 2017; Siswono, 2005; Widodo et al., 2018), planning for solving a problem is shown by organizing information or data creatively by using certain strategies to find possible solutions (Siswono, 2010). Understanding and planning problem solving requires an adequate creative thinking ability

of students because these abilities are high-level and critical thinking skills (Krulik & Reys, 1980; Krulik & Rudnick, 1999; Posamentier & Krulik, 2009; Siswono, 2011).

To measure the ability to think creatively, in fact, the government, through the Ministry of Education and culture, has used it on standardized questions i.e national exam questions (Istianah, 2013; Widana et al., 2019; Wulandari, 2014). related to this, teachers need to train students to have adequate creative thinking skills, especially in learning mathematics. One that can be used by teachers to improve the ability to think creatively by using learning models that can support students' thinking power to be creative (Noer, 2011). This is because learning provides opportunities for student activity to construct their own knowledge, in general can increase the flexibility of mathematical skills and improving creative skills.

Thus, it is thought to lead to learning that can develop mathematical creative thinking skills that must depart from learning that makes students active. In learning that prepares students active, students are given the freedom to think and question again what they receive from their teacher. Therefore, there needs to be an effort to search for and seriously apply the results of research on mathematics learning approaches, which can actively involve students in the classroom and be able to improve students' creative thinking abilities in learning mathematics.

The ability to think creatively is possible to be enhanced by learning (Hasratuddin, 2010; Ismaimuza, 2013; Noer, 2011; Siswono, 2005; Soviawati, 2011; Sumarmo et al., 2012). Hasratudin (2010) and Soviawati (2011) research results show that in general realistic mathematics learning can improve students' creative thinking abilities. The results of research conducted by Ismaimuza (2013) on junior high school students in Palu obtained that students' creative thinking abilities by using problem-based learning with cognitive conflict are better when compared to using conventional learning. The same thing was expressed by Siswono (2005), which stated that with learning in the form of problem submission, students' creative thinking skills could increase. One learning that can be used to improve the ability to think creatively including learning with an advocacy approach (Nurhasanah & Julyanti, 2019; Suhartono & Patma, 2018; Tandililing, 2013). An advocacy approach is an approach that seeks to enable students to be actively involved in the process of learning mathematics in class. Student activity is manifested in proposing the resolution of a mathematical problem given by the teacher through a process of debate. By actively involving students in the debate process, It is hoped that students' mathematical creative thinking skills will continue to be well trained through debate learning that debate engages students.

The advocacy approach is commonly used in social science learning and can provide opportunities for students to discuss social problems or issues and personal problems through direct involvement and personal participation in the debate process (Suhartono & Patma, 2018). However, judging from its characteristics, an advocacy approach does not rule out the possibility to be used in mathematics learning (Nurhasanah & Julyanti, 2019). This is because this learning can invite students to think creatively in the learning process, so it has an opportunity to improve students' mathematical creative thinking itself (Mustikasari, Zulkardi, & Nyimas, 2010). Based on this, the purpose of this study was to determine the increase in students' ability to think creatively in advocacy learning by using open-ended problems.

2. METHOD

This study uses an experimental method with a nonequivalent control group design (Creswell, 2012a, 2012b). This is because the researchers tested the application of an

advocacy approach by presenting open-ended problems in learning mathematics in schools. This study involved two classes that were made in two categories of sample groups, namely the experimental group that was given the treatment of an advocacy approach by presenting open-ended problems in mathematics learning, and the control group that was given the treatment of conventional mathematics learning, namely learning mathematics that is often done by teachers.

The subjects in this study were 72 students who were divided into two classes. Where the two classes used as research subjects were taken using random cluster sampling. This sampling technique is done randomly based on classes that have been formed not based on students. The instrument used in this study was a test of mathematical creative thinking ability. This test is given before and after treatment to students who are subjected to research. Mathematical creative thinking ability test consists of 7 items in the form of description. Indicators of mathematical creative thinking ability tests include fluency, flexibility, authenticity, and elaboration in dealing with the mathematical situation it faces (Siswono, 2004, 2005, 2010, 2011).

The data obtained in this study are data about learning models, students' creative thinking abilities, and general mathematical abilities. for general mathematical abilities are divided into 3 groups: upper, middle, and lower groups. The data processed in this study is normalized gain (N-Gain) data in the form of a percentage. First, a descriptive statistical analysis is performed, calculating the mean, variance, and standard deviation of each group of data, so that a general picture can be obtained. Second, statistical inference analysis is performed by applying one-way ANOVA statistics by considering assumptions that must be met, such as normality assumptions and homogeneity assumptions of variance (Stahle & Wold, 1989). If these assumptions cannot be fulfilled then statistical inference analysis uses the Mann-Whitney test (Glass, Peckham, & Sanders, 1972; Liliefors, 1967; Martin & Games, 1977).

3. RESULTS AND DISCUSSION

3.1. Results

Table 1 is the average results and variants of the mathematical creative thinking ability test scores from the experimental and control groups.

Table 1. Mathematical Creative Thinking Ability Test Data

Group	Pretes		Postes		N-Gain (%)	
	Mean	Variance	Mean	Variance	Mean	Variance
Experiment	1.15	5.15	13.47	70.39	37.07	527.62
Control	1.43	4.33	9.71	34.81	24.94	252.81

Based on Table 1, it is found that the average for the experimental group is better when compared to the experimental group. As in the pre-test mathematical creative thinking ability, the experimental group obtained an average of 1.15, while for the control group of 1.43. In the post-test, the experimental group obtained an average of 13.47, while that of the control group was 9.71. In N-Gain, the experimental group obtained an average of 37.07, while that of the control group was 24.94.

Furthermore, to find out better learning between the two lessons used, the N-Gain average difference test on the creative thinking abilities of students is carried out. The average for N-Gain in the experimental group was 37.07, with a variance of 527.62, while

the N-Gain for the control group was 24.94, with a variance of 252.81. Because one of the two N-Gain data to be tested does not meet the normality assumption, the test used in this case is the Mann-Whitney upper-tailed test. The summary of the statistical tests is presented in Table 2.

Table 2. Summary of Mann-Whitney N-Gain Test Results

Comparison	N-Gain		
	W	**P**	**Decision**
Experiment Vs Control	1533.5	0.0068	There is different

From Table 2, it shows that the significance coefficient is 0.0068 so that the increase in mathematical creative thinking abilities in students using an advocacy learning approach with the presentation of open-ended problems is significantly better than students who have conventional mathematical learning. Furthermore, because the increase in students' mathematical creative thinking abilities in the experimental group is better when compared to the control group, the N-Gain is analyzed based on general mathematical ability based on the upper, middle, and lower groups in the experimental group (groups of students who use an advocacy approach with problem presentation open-ended).

Table 3. The Mean and Deviation N-Gain Based on General Mathematical Ability

General Mathematics Ability Group	N	N-Gain Mathematical Creative Thinking Abilities (%)	
		Mean	**Standard Deviation**
Upper	8	59.94	24.52
Middle	22	32.76	18.87
Lower	6	22.38	13.42

Table 3 is the mean and standard deviation of N-Gain data on mathematical creative thinking abilities of students in the experimental group based on general mathematical abilities. Based on Table 3, it was found that the average mathematical creative thinking ability in the experimental group students based on general mathematical abilities was relatively different. This is because the mean score of students in the General Mathematics Ability Group in the upper category is 59.94, the mean student in the General Mathematics Ability Group is 32.76 in the middle category, and the mean student in the General Mathematics Ability Group in the lower category is 22.38. These results indicate that the upper group has an average N-gain, which is relatively higher than the other two groups.

Table 4. One-way Anova of N-Gain based on general mathematics ability in the experiment group

N-Gain	**Comparison of General Mathematics Ability Group**	**F**	**P**
Mathematical Creative Thinking Abilities	Upper, Middle, and Lower Groups	5.75	0.007

The results of this average difference need to be tested further, this is done to find out whether the three General Mathematics Ability groups have significant differences.

The calculation one-way Anova of N-Gain based on general mathematics ability in the experiment group, obtained thet F is 7.72 with a significance coefficient of 0.002 (Table 4). Based on these results, it can be concluded that the improvement of students' mathematical creative thinking skills between the upper, middle, and lower groups in the experimental class is in different conditions. To find out which General Mathematics Ability group has better creative thinking skills, followed by post-hoc anova test, in this study the post-hoc anova test used the Turkey test. Based on the Tukey test, in the experimental group there were significant differences between the upper group and the two other N-Gain groups. These results can generally be seen in table 3, that the mean of general mathematics ability in upper is higher than the mean of other general mathematics ability.

3.2. Discussion

The results of the N-Gain analysis on students' mathematical creative thinking abilities have increased, and the experimental class students looked better improved than the control class. Students can analyze the arguments of a statement or conclusion given if the student has a minimum of knowledge of mathematical concepts that are relevant and correct and can show the relationship with the statements and conclusions given. In this connection, learning through an advocacy approach by presenting open-ended problems has given students broad opportunities to think freely, raise opinions or ideas, ask questions, and criticize the opinions of friends, especially in the process of solving problems given by the teacher. This is what seems to make students in the experimental class accustomed to display their arguments that support the ideas, statements, or conclusions that they propose. Also, with the learning process carried out in the experimental class, students seemed to be doing a lot of exploring mathematical concepts in depth. Thus, students in the experimental class have more opportunities to gain knowledge of relevant and correct mathematical concepts, and show their relationship to the statements and conclusions they provide, than students in the control class.

Students can do and consider induction if students can predict, test a rule of observed patterns, and proceed with formulating it. In this study, the ability of students to do and consider induction is certainly influenced by their mastery of the concept of function. One of the material functions related to determining the formula of a function if known several values of the function.

Learning through an advocacy approach by presenting open-ended problems has provided opportunities for students to explore and try various ways of solving. This is what seems to make students in the experimental class accustomed to estimating, testing a rule of observed patterns, and then proceeding with formulating it. Meanwhile, students in the control class have inadequate opportunities regarding things experienced by students in the experimental class; this is due to the characteristics of learning in the control class.

Students who can smooth or think fluently are students who can express many ideas, answers, and problem-solving. In this connection, learning through an advocacy approach by presenting open-ended problems has given students ample opportunity to think freely, submit opinions or ideas, and ask questions. This is what seems to make students in the experimental class accustomed to displaying their ideas in solving problems or problems given by the teacher.

Students who can authenticate or think original are students who can come up with ideas in original ways, not cliched, rarely given by most people. Meanwhile, students who can be flexible or think flexible are students who can express various solutions or approaches to problems. In this connection, learning through an advocacy approach by presenting open-ended problems has conditioned students to have a different solution from

the problem or problem is given, consider solving other students who are considered new, so that inviting other students to give opinions, comments, or criticism, in a debate. This is what seems to make students in the experimental class accustomed to finding a variety of answers that are relatively new to students.

Students who can elaborate or think in detail are students who can describe something in detail, enrich, and develop an idea. In this connection, learning through an advocacy approach by presenting open-ended problems has conditioned students to prepare or add details of an idea to ward off criticism of other students. This is what seems to make students in the experimental class accustomed to describing things in detail, building relationships, and enriching and developing ideas.

The findings of this study indicate that the posttest score of students' creative thinking ability in the experimental class, which is 13.47, with an ideal score of 35. These data indicate that the mathematical creative thinking ability of students in the experimental class, the results are not optimal. This is most likely caused by students who are not accustomed to learning through an advocacy approach by presenting open-ended problems. Also, it is suspected that the results are not optimal in the experimental class due to the portion of the difficult questions on the set of tests used, which is more than 70% of the total number of questions. This is consistent with students' recognition of the results of interviews and daily journal notes, which state that the questions given in the learning process or tests are more difficult than the questions that are normally given by the teacher in conventional learning or conventional learning. Thus, the results of this study might be different if the number of questions is difficult to reduce portions.

As for the differences in the improvement of students' mathematical creative thinking abilities between the upper, middle, and lower groups in the experimental class, based on the results of the one-way ANOVA statistical test, there are significant differences. This means that learning through an advocacy approach by presenting open-ended problems has a different effect on increasing mathematical creative thinking abilities, for each group of students' general mathematical abilities.

Several reasons can be put forward to explain the difference in the increase in mathematical creative thinking abilities between the three groups of students in the experimental class. One possible reason is that students for the lower and middle groups are not yet accustomed to openly expressing ideas, questions, or answers, thus hampering the development of students' mathematical creative thinking abilities. This is consistent with the results of the interview, representatives of the lower classes, who stated that some of their friends did not like the difficult or challenging problems or problems contained in the teaching material, so they were lazy to solve them. Also, there were friends who were shy to ask questions. Thus, for the lower class students who still feel ashamed to express ideas, questions, and criticize the opinions of other students, it will inhibit the increase in mathematical creative thinking abilities.

The difference in the increase of creative thinking skills between the three groups of students in the experimental class can be attributed to the concept of Zone of Proximal Development from Lev Vygotsky which states that children's cognitive abilities are divided into two stages, namely the stage of actual development and potential development (Bruner, 1984; Herlina, 2013; Kotliar, Sokolova, & Tarasova, 2009). In this connection, the intervention given by the teacher to students in the learning process is adjusted according to differences in the level of the actual development of students to reach their potential level of development (Permatasari, Wayhuno, & Adi, 2017; Smagorinsky, 2018). This difference in intervention seems to be the reason for the difference in the ability to think critically and creatively between the three groups of students in the experimental class. The difference in the increase in the ability to think creatively between the three

groups of students reinforces the results of previous findings, which state that the level of mathematical ability of students also determines the improvement of high-level mathematical abilities (Guseva & Solomonovich, 2017; Murphy, Scantlebury, & Milne, 2015; Shodikin, 2014).

Furthermore, for group students on learning through an advocacy approach by presenting open-ended problems is learning that has helped them develop and demonstrate mathematical creative and critical thinking skills, even if viewed from the results are not optimal. However, that does not mean that the middle and lower learning groups do not help them develop and demonstrate mathematical creative thinking skills. This, because when viewed as a whole, students in the experimental class have improved mathematical creative thinking abilities better than students in the control class.

4. CONCLUSION

The results of the study concluded that improving students' mathematical creative thinking abilities given the treatment of an advocacy approach by presenting open-ended problems in mathematics learning was better than students who were given conventional learning treatments. Also, the increase in mathematical creative thinking skills, between students in the upper, middle, and lower groups in the experimental group, did not differ significantly even when viewed from the mean of the upper group having better abilities when compared to other groups.

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