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Problem Posing to Develop Students' Mathematical Creativity

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ABSTRACT

Student creativity in the process of learning mathematics is very necessary. The low ability to think creatively will greatly affect the overall learning outcomes. One alternative learning that can be used is the problem posing approach. This study aims to determine whether the Problem Posing approach has an effect on students' mathematical creativity. Quantitative research methods with data analysis techniques using the F test are used in this study. The essay test instrument was used to collect data on students' creative thinking abilities. The results showed an increase in students' mathematical creativity after using the Problem Posing approach. The results showed that the effect of the Problem Posing approach on mathematical creativity was 40.49%, this is in the high category. Based on these results, the problem posing approach can be an alternative for teachers in increasing the creativity of students who are still low.

Keywords: Problem Posing Approach, Mathematical Creativity

ABSTRAK

Kreativitas siswa dalam proses pembelajaran matematika sangatlah diperlukan. Rendahnya kemampuan berpikir kreatif ini akan sangat berpengaruh terhadap hasil belajarnya secara keseluruhan. Salah satu alternatif pembelajaran yang dapat digunakan ialah pendekatan problem posing. Penelitian ini bertujuan untuk mengetahui apakah pendekatan Problem Posing berpengaruh terhadap kreativitas matematis siswa. Metode penelitian kuantitatif dengan Teknik analisis datanya menggunakan uji F digunakan dalam penelitian ini. Instrumen tes essay digunakan untuk mengambil data kemampuan berpikir kreatif siswa. Hasil penelitian menunjukkan adanya peningkatan kreativitas matematis siswa setelah menggunakan pendekatan Problem Posing. Hasil penelitian menunjukkan bahwa pengaruh pendekatan Problem Posing pada kreativitas matematis sebesar 40,49%, hal ini masuk pada kategori tinggi. berdasarkan hasil ini, pendekatan problem posing dapat menjadi salah satu alternatif bagi guru dalam meningkatkan kreativitas siswa yang masih rendah.

Kata kunci: Pendekatan Problem Posing, Kreativitas Matematis

INTRODUCTION

Kilpatrick (2001) argues that mathematics should not be taught the way their parents learned. This is confirmed by Pound & Lee (2010) that mathematics must be taught so as to produce students who are competent in original thinking and original values. Although there is debate among experts about creativity that results in thinking about novelty, "must" is the domain of genius students with special talents. (Singer, 2018). However, in the end they agreed that the competence of creative thinking in mathematics, all students have the right to achieve it according to the capacity of each individual (Pound & Lee, 2010).

The agreement implies that all students have the right to learn mathematics, the content of which is to condition learning opportunities to be creative through mathematics lessons. The problem is, it is indicated that the mathematics lessons that are carried out are not much in favor of all students' ability levels, to be in the domain of creative mathematics lessons. This indication can be read from the results of the 2018 Program for International Student Assessment (PISA) published in March 2019 which measured the ability of 600 thousand 15-year-old children from 79 countries. (Mitari & Zulkardi, 2019). In the mathematics category, Indonesia is ranked 7th from the bottom (73) with an average score of 379, down from rank 63 in 2015 (Hidayat et al., 2020). It is interesting to note that the Indonesian children who were selected to participate in PISA are gifted children.

PISA results also indicate that mathematics learning tends to provide routine things (Hidayat et al., 2020). Hafriani, (2021) argues that new courses are needed so that students are also accustomed to practicing non-routine questions based on solid reasoning. All the improvement efforts made of course take time to enjoy the results.

One of the efforts researched and published in this article is the provision of mathematical problem posing. This effort was carried out with several empirical and theoretical considerations. Empirical considerations, the results of the meta-analysis conducted by Kul & Çelik (2020), Kul & summarized 20 experimental studies published between 2000 and 2020. Based on the random effects model, it was found that problem posing strategies had a significant effect on students' problem solving skills, mathematics achievement, level of problems posed, and attitudes towards mathematics..

The theoretical considerations, Gonzales (1998) states that the problem posing approach should be the fifth stage of Polya .'s four-stage problem solving process. El Sayed (2002) also states that problem posing-based learning contributes to the formation of relationships between everyday life situations and mathematics and is an effective approach to developing students' mathematical thinking. There are a large number of published studies that describe the importance and meaning of problem posing and there are various definitions of problem posing related to creativity. For example, problem posing is defined as a cognitive activity that involves students generating new problems under certain conditions or generating new problems by modifying the proposed problem (Silver, 1994; Lavy & Shriki, 2007; Tichá & Hošpesová, 2009; Cai et al., 2015; NCTM, 2000). With such an understanding, it is necessary to produce innovative mathematics learning so that it develops students' creativity.

Several studies related to the application of the problem posing approach have shown that this approach can improve learning achievement (Amiluddin & Sugiman, 2016; Astra & Jannah, 2012; Guntara et al., 2014; Irawati, 2014), motivation of learn (Rosyida et al., 2017), mathematical problem solving skill (Daryati & Nugraha, 2018; Iswara & Sundayana, 2021), concept understanding

(Herawati et al., 2010), critical thinking (Sasmita & Harjono, 2021) and student comminacation (Juano & Pardjono, 2016; Persada, 2014). Research conducted by Van Harpen & Sriraman, (2013) focuses on students' ability to pose problems as part of students' creativity in the classroom through problem posing. In this study, the researcher involved all indicators of student creativity based on Hurlock's (1980) theory. Specifically, the objectives of this study are to uncover and analyze: (1) the effect of learning mathematics with the Problem Posing approach on students' mathematical creativity; (2) The effect of learning mathematics with Problem Posing approach according to different levels of students' abilities on students' mathematical creativity; (3) The contribution of mathematics learning with the Problem Posing approach to students' mathematical creativity.

METHOD

This research is an experimental study with the design of One Group Pretest Posttest Study (pre-test post-test design in one group) which includes one group that is observed at the pre-test stage which is then followed by treatment and post-test (Creswell, 2012). The instrument used to collect data in this study was a test. As for the learning activities, lesson plans and teaching materials are made in the form of a Problem Submission Task Sheet (LTPM) on the Many Tribes material. Mahmudi (2010) argues that open questions can measure creative thinking skills with the characteristics of questions that have various solutions or settlement strategies. Another method is the problem posing method, which is making questions, questions, or statements related to certain mathematical problems or situations.

To reveal how students' mathematical creativity which includes fluency, flexibility, originality, detail and evaluation (Hurlock, 1980), in solving students' mathematical problems by learning mathematics through a problem posing approach. The data obtained from the test results were processed through the following stages: (1) giving students' answer scores according to the scoring guidelines used. To process creative thinking ability data using the percentage formula with SMI determined from the creative thinking ability scoring rubric according to Hendriana & Soemarmo (2014).

$$Value = \frac{Student\ score}{ideal\ \max score} \times 100\%$$

While the criteria for completeness of mathematical creative thinking skills according to Arikunto (2021) are presented in Table 1.

Table 1. Criteria for Creative Ability Values

Value	**criteria**
68% - 100%	crative
33% - 67%	Quite Creative
< 33%	Less Creative

(2) perform a normality test to determine the normality of the mathematical creative pretest and posttest score data through the SPSS for Windows version 18.0 program. If the data is not normally distributed, then the data outliers are checked with a Z-score or if it is not successful, then proceed with data transformation; (3) to test the homogeneity of the variance of the mathematical creative pretest and posttest score data through the SPSS for Windows version 18.0 program. If the data is not homogeneous, then there will be an output of the value of one or several samples in the study; (4) to determine the effect of students' ability level on students' mathematical creativity, a two-way ANOVA

statistical test was carried out, provided that the previous data were normal and homogeneous; (5) to find out how big the contribution of mathematics learning with the Problem Posing approach to the level of students' mathematical creativity is done by using Effect size; (6) interpretation of data from statistical test results.

RESULT AND DISCUSSION

Result

The research was conducted from January 11 to January 20, 2016 in class XI IPA3 Senior High School No 1 at Sungai Kakap, Kubu Raya Regency. The research results based on the objectives of this study are as follows.

Learning mathematics with Problem Posing approach to students' mathematical creativity

Because $\propto = 0.05$ is greater than Significance is 0.00 and $F_{count} = 25.963$ is greater than $F_{0.05;1;58} = 4.006$, the null hypothesis is rejected. By paying attention to the mean scores of the pretest and posttest, it is concluded that: the mean score after learning mathematics using the problem posing approach (18.34) is significantly better than the mean score before learning mathematics using the problem posing approach (9.72).

Learning mathematics with Problem Posing approach according to the ability level of students

Because $\propto = 0.05$ is greater than Significance is 0.00 and $F_{count} = 25.470$ is greater than $F_{0.05;2;58} = 0.114$, the null hypothesis is rejected. There are differences in the mean scores of each student's ability level, so it can be concluded that: the post-test mean score on the ability of upper-level students (28.60) is better than middle-level students (17.26) and lower level (12.20).

Interaction between learning and Student Ability Level

Because $\propto = 0.05$ is smaller than Significance is 0.892 and $F_{count} = 0.114$ is smaller than $F_{0.05;2;58} = 3.156$ then H is accepted. There is no significant interaction between the application of different mathematics learning according to the different levels of students' ability to students' mathematical creativity.

Discussion

Table 2. Mathematical Creativity Ability Achievement

Aspect	Indicator	No	Pre-test			Pos-test		
			Min	Max	Mean	Min	Max	Mean
Fluency	1	1a	0	4	5,03	0	4	7,41
		2a	0	3		0	4	
		3a	0	3		0	4	
Flexibility	2	1b	0	3	1,97	0	3	5,31
		2b	0	2		0	3	
		3b	0	3		0	3	
Novelty	3	1a	0	2	2,72	0	4	5,62
		1b	0	2		0	2	
		2a	0	2		0	3	
		2b	0	1		0	2	
		3a	0	2		0	3	
		3b	0	1		0	1	
Upper Group					19,60			28,60
Midle Group					8,37			17,26
Botton Group					5,00			12,20

Table 2 shows that the average score of all levels of students' ability above, middle and lower has increased. The average score of the upper students' ability level increased from 19.60 to 28.60. The average score of the ability level of middle students increased from 8.37 to 17.26 and the average score of the lower students' ability level increased from 5.00 to 12.20. This means that there is an increase in students' mathematical creative abilities after learning mathematics with a problem posing approach in terms of students' ability levels. The distribution of mathematical creative abilities at the level of the upper students' ability is close to the same, namely SD pretest 4.16 to 1.52, meaning that the upper students on average increase their mathematical creative abilities, as well as the mathematical creative abilities of lower students, while the distribution of mathematical creative abilities at the middle level of students. more variable.

Table 2 can be described about the achievement of indicators, namely there is an increase in the level of mathematical creativity of students in indicator 1 with an average value at the pretest of 5.04 to 7.41 at the posttest, students have increased in completing polynomial operations which include addition, subtraction, and multiplication. tribes by asking questions and solutions that are new, unique, or unusual. With an increase in the value of the standard deviation of the achievement of Indicator 1, it shows that the students' ability to complete the Multiracial Operation with an increasing difference. At the achievement of Indicator 2, it is seen that there is an increase in the average ability, namely from pretest of 1.97 to posttest of 5.31, an increase in students' ability to determine the value of a Many Tribe by using direct substitution and schemes by asking questions and solving new ones, unique, or unusual. Likewise, an increase in the value of the standard deviation indicates that the ability of students to determine the value of a tribe has increased differences. Furthermore, the achievement of Indicator 3 is seen to have increased in average ability, namely from the pretest of 2.72 to the post-test of 5.62. This shows an increase in students' ability to determine the quotient and remainder of the division of many terms by asking questions and solutions that are new, unique, or unusual. Likewise, an increase in the value of the standard deviation shows that the students' ability to determine the quotient and remainder of the division of many terms has increased differences.

In Table 2 the posttest results for number 1.a with indicators of creative thinking skills, namely students can ask many questions about inter-tribal operations that can be completed. There are 10 students who can ask 3 or more questions, 12 students who can ask 3 questions, 3 students who can ask 2 questions, 2 students who can ask 1 question, and 1 student does not answer. Out of 10 students who can ask 3 or more questions. Furthermore, of the 5 students who can ask 1 question, 4 of them are students from the lower ability group and 1 student from the middle ability group. This indicates that the students in the upper ability group are not classified as uncreative students. While the 7 students who did not answer were students from the middle class ability group.

From the results of the post-test for number 3.a with indicators of creative thinking skills, students can ask many questions about the division and remaining polynomials that can be solved. There are 2 students who can ask 3 or more questions, 17 students who can ask 3 questions, 1 student can ask 2 questions, 4 students who can ask 1 question, and 5 students do not answer. Of the 3 students who can ask 1 question, and 1 student who does not answer is a student from the lower ability group. This indicates that students in the lower ability group are not very creative students. For the achievement of question numbers 1.b, 2.b and 3.b there are still students who do not show the students' creative mathematical abilities in the aspect of flexibility both for pretest and posttest questions, this is indicated by a score of 0 at the minimum pretest and posttest. The average value for the achievement of the number of questions 1.b, 2.b and 3.b all three increased after learning mathematics with a problem posing approach. Meanwhile, the distribution of data for the achievement of the three questions 1.b, 2.b and 3.b increased, meaning that the students' mathematical creative ability in the flexibility aspect experienced a higher difference between students in the non-creative and very creative categories.

From the results of the post-test for number 1.b with indicators of creative thinking skills, students can ask questions about Operations between multiple tribes that can be solved in different ways. There are no students who can give more than two different and correct solutions, 12 students who can give two different and correct solutions, 3 students can give 1 correct and 1 solution, 13 students who can give correct answers. 1 or more completion and wrong and 1 student did not answer. All students from the upper student ability group can give two different and correct solutions. This indicates that students from the top student ability group are not classified as uncreative students.

From the results of the posttest for number 2.b with indicators of creative thinking skills, students can ask questions about the value of polynomials which can be solved in different ways. There are no students who can give more than two different and correct solutions, 4 students who can give two different and correct solutions, 11 students who can give 1 correct solution, 7 students who can give 1 or more solutions and wrong and 7 students did not answer. All students from the upper, middle and lower ability groups cannot give two or more different and correct solutions. This indicates that students from the lower ability group are not very creative students.

From the results of the post-test for number 3.b with indicators of creative thinking skills, students can ask questions about the division of polynomials which can be solved in different ways. There are no students who can give more than two different and correct solutions, 8 students who can give two different and correct solutions, 2 students who can give 1 correct solution, 14 students who can give 1 or more solutions and wrong and 5 students did not answer. All students from the upper, middle and lower ability groups cannot give two or more different and correct solutions. This indicates that students from the lower ability group are not very creative students. For the achievement of question numbers 1.a,1.b, 2.a, 2.b, 3.a and 3.b there are still students who do not bring up the students' mathematical creative abilities in the novelty aspect for both pretest and posttest questions, this is indicated by a value of 0 in the minimum pretest and posttest.

The average value for the achievement of all number questions has increased after learning mathematics with a problem posing approach. Meanwhile, the distribution of data for the achievement of question numbers 1.a, 2.a, 2.b, and 3.a increased. This shows that the students' mathematical creative abilities in the novelty aspect experienced a higher difference between students in the non-creative category and very creative, on the contrary, for the achievement of question numbers 1.b and 3.b, the students' mathematical creative abilities in the novelty aspect with smaller differences between students in the non-creative category. and very creative. From the results of the posttest for numbers 1.a and 1.b with indicators of creative thinking skills, namely students ask questions and solutions that are new, unique, or unusual regarding polynomial operations. There is one student who can ask questions of more than 2 unique ideas, and two students who can ask questions of 2 unique ideas.

Furthermore, from the results of the pretest and posttest as shown in Table 3 for question numbers 1.a and 2.a there are students who have a minimum score of 0, this shows that there are still students who have difficulty in the fluency aspect with indicators, namely students can ask many questions about Operations. between polynomial that can be solved and students can ask many questions about the value of the polynomial that can be solved. For question numbers 1.b, 2.b and 3.b there are students who have a minimum score of 0, this shows that there are still students who have difficulty in the aspect of flexibility with indicators, namely students can solve in many different ways regarding operations between polynomials, The value of the polynomial and the division of the polynomial. For all numbers, there are students who have a minimum score of 0, this shows that there are still students who have difficulty in the novelty aspect with indicators, namely students can ask questions and solve in many different ways that are unique regarding Operations between polynomials, Many Tribal Values and Tribal Divisions Lots

In general, the contribution of learning with the Problem Posing approach to the level of students' mathematical creativity is 40.49%, this means that there are still students experiencing difficulties or obstacles in mathematical creative abilities after learning with the Problem Posing approach. Factors that cause students not to be creative in problem posing include; (1) students are not used to coming up with new or unique ideas, (2) students are not skilled in understanding language. Students experiencing difficulties or obstacles in mathematical creative abilities indicate that students learn only by memorizing, following the teacher's example questions, and there is no skill in understanding language, as stated by Pramono (2012) that students learning mathematics really need skills in understanding language. By understanding the language, the result can recognize problems in mathematics, logic, imagination and creativity. Based on the findings of PIRLS 2011 (Puspendik Team, 2011) it is mapped that the reading ability of Indonesian students, both at the international and national level, is still low. There are many factors that cause it. Some of them are students' internal factors such as low habits, interests, motivation, and reading culture; the reading learning system in schools is not adequate; literacy issues have not been used as the basis for developing curriculum and textbooks and books on the Level of Student Mathematical Creativity; inadequate availability of facilities and infrastructure in the form of books in the library; and a weak scoring system. Regarding language skills in mathematics learning according to Izzati & Suryadi (2010) in the mathematics learning process, students are encouraged to go through four steps that describe the actual mathematical situation: (a) Natural language, where students are allowed to use their own language; (b) the main/important language, this stage includes the use of terms in concrete or image models; (c) speed reading, this stage allows students to use several words to formulate mathematical situations; (d) symbol language, this involves the use of terms and symbols as a simpler and more complete way of recording mathematical problems. The active, thought-provoking use of language is a means for students to negotiate the meaning of their experiences.

CONCLUSION

Based on data analysis and hypothesis testing, it can be concluded several things related to this research as follows; (1) There is an effect of learning mathematics with the Problem Posing approach on students' mathematical creativity in the Multi-ethnic material, (2) there are differences in students' mathematical creativity between students at the upper, middle, and lower ability levels in learning mathematics with the Problem Posing approach, (3) contribution Mathematics learning with Problem Posing approach to students' mathematical creativity by 40.49% can be categorized as Large, (4) there is no interaction between students' ability levels and students' mathematical creativity levels. The mean of the Upper group is higher than the Middle or Lower group and the average of the Middle group is higher than the Lower group.

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