Journal of Primary Education
9 (1) (2020) : 58 – 65

https://journal.unnes.ac.id/sju/index.php/jpe/article/view/36047

Creative Mathematical Thinking Ability in Creative Problem Solving Model Viewed from Gender

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Article Info

History Articles
Received:
November 2019
Accepted:
December 2019
Published:
January 2020

Keywords:
creative thinking abilities, creative problem solving (CPS), gender

DOI
https://doi.org/10.15294/jpe.v11i3.36047

Abstract

Mathematical creative thinking ability in problem solving becomes the requirement of mathematics education recently in order to find many ideas and new solution so that the issues can be resolved appropriately. This study aims to determine the effectiveness of Creative Problem Solving (CPS) learning in achieving the student's creative mathematical thinking ability and their ability viewed from gender. This study used a mixed method design with concurrent embedded design by conducting quasi experimental design on quantitative method and Miles-Hubberman model to analyzed qualitative data. The first stage was quantitative data collection, and it was done using tests (essay). The next stage was qualitative data collection, and it was done using triangulation techniques such as tests and interviews. The study population was the grade VII SMP IT Bina Amal Semarang. Samples were grade VII Thoriq and VII Aisyah as an experimental class and grade VII Amru and VII Asma ' as the control class. Data analysis in qualitative research follows the concept given by Miles & Huberman are data reduction, data display, and conclusion drawing/verification. Analysis of quantitative research includes analysis of the achievement aspects of mathematical creative thinking abilities. Quantitative data analysis includes a normality test, homogeneity tests, completeness tests, right-side tests, and average similarity test. The result of this study shown that CPS learning model effectively improved the ability of creative thinking viewed from gender, this is indicated by the mathematical creative thinking ability of the experimental class students reaches the minimal past score, the mathematical creative thinking ability of the experimental class students is better than of the control class, the mathematical creative thinking ability of female students are better than male on elaboration and flexibility indicators, whereas the mathematical creative thinking ability of male students are better than female on fluency and originality indicators. Based on the results, it can be concluded that CPS learning can improve student's creative thinking abilities and different achievement between male and female students.

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p-ISSN 2252-6404
e-ISSN 2502-4515

INTRODUCTION

The challenges of the world are even greater and competition is getting tougher, so that requires competencies of graduates who are not only skilled in one competency but also creative in developing their competencies. Therefore, the experts and observers of education give intensive attention to develop the concept of talent, which is composed of three aspects are intellectual excellence, attachment to a task (motivation), and creativity. Efforts to develop the concepts have changed the direction of improvement and National Policy. This has been seen in the learning process in every subject in the school, including mathematics.

Creative thinking ability in mathematics learning is the ability to stimulate students to find diverse solutions or ideas in mathematics problem solving (Sari, 2016). According to Alvani (2016), creative thinking is an important part of thinking to be developed. McGregor (2007) also said in his study that creative thinking is thinking that leads to gaining new insight, new approaches, new perspectives, or new ways of understanding things. Johnson & Johnson (2010) said that creative thinking is a habit of thinking that is trained by seeing to intuition, light up the imagination, reveal the new possibilities, open the amazing perspectives, and find the unexpected ideas. Furthermore, Alvino (Sumarmo, 2010) explains that creative thinking contains four components is fluency, flexibility, originality, and elaboration.

The result of preliminary studies in SMP IT Bina Amal shows that student's mathematical creative thinking skill is still not satisfactory. Students, especially in class VII, still have difficulty in solving non-routine problems in various ways that might be done to answer them. The questions given at the school are ordinary questions, so students are not habitual to high order thinking skill including creative thinking. This has an impact on students themselves if the students have not been able to develop their mathematical creative thinking skills, it will affect the learning outcomes. Because, students will be able to develop many ideas, thoughts, and new things by creative thinking that can change their perspective, their way of thinking and their approach.

Based on facts in the class, then it is necessary to fix the teaching and learning process so that mathematical creative thinking skills can be improved. One effort to improve the quality of education is to improve the quality of learning (Sri, Haryono, Sulistyo, 2012). Learning that allows facilitating students to be able to improve mathematical creative thinking skills is a Creative Problem Solving model that is often known as the CPS model.

The CPS model consists of problem clarification, disclosure of opinion, evaluating and selection, and implementation. By habituating students to independent steps in solving problems be expected to help students to improve student's mathematical creative thinking skills. Efforts to improve student's mathematical creative thinking skills supported by class group discussion settings. The group distribution is expected can encourage mutually supportive relationships between group members. The students who have difficulty can ask the teacher or other students.

The research by Zhu (2007) explains that there are differences in mathematical solutions affected by gender, experience, and education differences. But this is different from other research that said there is no gender differences occur in overall intellectual skill, but gender differences arise in several cognitive areas, like math and verbal skills. Boys have better visual-spatial skills than girls (Santrock, 2014). Krutetskii in Nafi'an (2011) explains the difference between boys and girls in learning mathematics is a follows: (1) boys are superior in logic, girls are superior in accuracy, precision, thorough, and deep thinking, (2) boys have better math and mechanics skills than girls, this difference does not appear at the elementary school level but becomes more pronounced at a higher level.

Hurlock (in Fitriyah, 2014) explains at the age of 12-13 years, boy's mathematical skills increase faster than in girls. This is because at the age of 12 years and over, boys and girls students are in puberty. In general, the effect of puberty is

more common in girls, partly because girls mature faster than boys. Because of this natural change, students who mature quickly tend to weaken their energy, so students become lethargic and display achievements below their abilities in all scope. As a result, female students tend to underachieve and this tendency often becomes a habit at puberty. This puberty occurs when students in Junior High School (SMP). Therefore, the researcher chooses Junior High School (SMP) students to be the subject of research.

According to that explanation, the purpose of this research were (1) to test the effectiveness of CPS research (2) to analyze mathematical creative thinking skills based on gender.

METHODS

This type of research is mixed-method with concurrent embedded models. This study unbalanced qualitative and quantitative methods. Qualitative research as a primary method and quantitative research is nested into more dominant methods. In this research, the data used are the data of student's mathematical creative thinking skills and the data on student learning styles.

In this research, a Qualitative research design focuses on activities to describe and explore or describing student's creative thinking skills in terms of learning styles and gender with a focus on learning mathematics CPS models. The quantitative research design in this research using a quasi-experiment design, it means designing research involving two groups that are experimental class and control class. This research implemented in SMPIT Bina Amal, Gunungpati, Semarang City, Central Java.

The sample of qualitative data in this research used a purposive sampling technique. This qualitative subject is 6 students consisting of 3 boy students and 3 girl students. The selection of students based on the level of mathematical creative thinking abilities and gender.

Quantitative data samples in this research were obtained by random sampling technique. From grade VII of SMAIT Bina Amal, 4 classes were chosen as a research sample according to research design.

The research instrument used is learning style questionnaire and test of mathematical creative thinking skills (TKBKM). Data analysis in qualitative research follows the concept given by Miles & Huberman (2007) are data reduction, data display, and conclusion drawing/ verification. Analysis of quantitative research includes analysis of the achievement aspects of mathematical creative thinking abilities. Quantitative data analysis includes initial data analysis and final data analysis. Initial data analysis includes normality tests, homogeneity, and average similarity test. The final data analysis includes a normality test, homogeneity tests, completeness tests, right-side tests, and average similarity test.

RESULTS AND DISCUSSION

Initial Research Data

Three tests were conducted for the initial data analysis, namely the normality test, the homogeneity test, and the average similarity test. Normally test results showed that the sig values of the two sample classes in the Kolmogorov-Smirnov test being 0.20 greater than 0.05 so that H_0 is accepted. Therefore, the initial data are normally distributed both experimental class and control class. In the homogeneity, it was obtained that the sig value of the sample class is $0.835 > 0.05$ so that H_0 is accepted. Therefore, the initial capability data has a homogeneous variance in creative mathematical thinking ability, both experimental class and control class. In the average of two similarity test obtained a sig value of $0.641 > 0.05$ so that H_0 is accepted, which means there is no difference in the average initial creative mathematical thinking ability in the experimental class and the control class.

Test of Research Data

Before testing the hypothesis, a prerequisite test was first performed, namely the normality test and the homogeneity test, to determine the statistical test that will be used in

the parametric test hypothesis or the nonparametric test.

Normally test results showed that the sig values of the two sample classes in the Kolmogorov-Smirnov test being 0.062 greater than 0.05 so that H_0 is accepted. Therefore, the test are normally distributed in creative mathematical thinking ability, both experimental class and control class.

In the homogeneity, it was obtained that the sig value of the sample class is 0.297 > 0.05 so that H_0 is accepted. Therefore, test data has a homogeneous variance, both experimental class and control class.

Descriptive statistics of the final data on the mathematical creative thinking ability of the experimental and control groups are presented in Table 1.

Table 1. Descriptive Statistics of Mathematical Creative Thinking Ability

Descriptive statistics	Experiment		Control	
	M	Fe	M	Fe
Average	71.71	65.18	71.56	65.20
Varians	40.51	62.16	44.03	81.08
Standard deviation	6.37	7.88	6.63	9.00
Completeness	80%	81%	68%	64%

Based on the mathematical creative thinking ability data in Table 1 and hypothesis testing to determine the effectiveness of the CPS model the following results are obtained. The first hypothesis test is related to the average mathematical creative thinking ability of students in the experimental class using CPS learning using the results of mathematical creative thinking ability test. The test result showed that $t_{\text{value}} = 76.937$ with a significance level 5% and $df = 48 - 1 = 47$ obtained $t_{table} = 1.671$ so that $t_{value} > t_{table}$ atau 76.937> 1.671 then H_0 is rejected, meaning the average mathematical creative thinking ability in the class using CPS model meets the minimal pass score, which was ≥ 65.

The second hypothesis test is the classical completeness test of students' mathematical creative thinking abilities in the classroom with CPS learning. Testing using the right hand test by looking at the z count value. Based on the calculation, $z_{value} = 1$ while the rejection area H_0 is $z_{value} > z_{table}$. The z value of the standard normal distribution $z_{(0,5-\alpha)} = z_{0,45} = 0.174$ because $z_{value} > z_{table}$ then H_0 is rejected. This means that students' mathematical creative thinking abilities in CPS learning with an average of 65 more than 75%.

The third hypothesis test relates to the test of the average difference of students' mathematical creative thinking abilities in classes using CPS learning models with students who use PBL learning models. The test was carried out with the help of SPSS 17.0, the test results showed that the value of $t = 4.190$ with a degree of validity $df = n - 1 = 48 - 1 = 47$ and a significance level of 5% was obtained $t_{table} = t_{(n-1,0,05)} = 1.658$ it can be seen that $t_{value} > t_{table}$ or $4.190 > 1.658$ then H_0 is rejected, meaning that the average mathematical creative thinking ability of students in the experimental class using CPS learning model is more than the average value of the mathematical creative thinking ability of the control class using PBL model learning.

Based on the analysis of research data, the effectiveness of the CPS learning model shows that: (1) the average mathematical creative thinking ability of students reaches more than 65, (2) the classical completeness of the mathematical creative thinking ability of students with CPS learning more than 75%, (3) the average mathematical creative thinking ability using the CPS learning model is better than the average mathematical creative thinking ability of students using the PBL model. These three results can be used as indicators that learning by using the CPS model on grade VII plane material is effective for improving students' mathematical creative thinking abilities.

The effectiveness of the CPS learning model is shown in the learning process. The habit of students in using creative steps in CPS learning has a role in helping to understand and overcome various mathematical problems, especially in solving problems related to creative thinking. Based on the test results, it can be seen that learning using CPS learning models can improve students' creative thinking abilities, according to the opinion of Hariawan, et al (2014) explaining

that the CPS learning model is a problem-centered learning model that emphasizes the balance between divergent thinking and converging besides the CPS learning model can also increase students' activities and creative thinking. This is in line with Jerome Bruner's learning theory (in Dahar, 2006) which states that students learn through active involvement between the knowledge they have to solve problems, and the teacher only acts as a motivator for students in gaining experience that allows students to find and solve problems.

The learning process with the CPS model can develop students' creative thinking skills so that most students can achieve classical completeness of more than 75%. It shows that the theory of "creative thinking skills are specific thinking strategies that can be developed through various teaching methods", one of the ways that can be used in teaching and learning to improve students' mathematical creative thinking abilities through varied learning models is true. Like the results of Cahyono's study (2007) which states that the implementation of the CPS model provides opportunities for students to choose and develop their ideas and thoughts. In contrast to memorization that uses little thought, CPS broadens students' thought processes.

The application of the CPS learning model gives students the opportunity to be actively involved in the teaching and learning process, students are trained to explore, search, ask questions, investigate questions or answers, manage and communicate their results communicatively. As a result, learning with CPS is more meaningful so that it can improve students' mathematical creative thinking abilities. This is in line with the results of Sundari's research (2016) which concluded that the use of CPS learning models results in a better understanding of concepts than the use of expository models. The results of the study are also consistent with research conducted by Indayatmi (2017) which concludes that learning with CPS can improve student learning activities and outcomes.

The CPS learning model is also effective in trying to get students used to discussing and cooperating with each other in an effort to solve math problems. This is supported by the statement of Cahyono (2007) that by using a technology-based CPS model can improve the activeness and skills of students in the learning process. This can be seen in the students' skill in implementing the learning processes. An active discussion process encourages students to improve students' mathematical creative thinking abilities. Students will get a better understanding of mathematics and have longer memories of knowledge as they solve problems, give mathematical reasons, prove mathematical relationships, participate in mathematical discourse, make mathematical connections and models, and represent mathematical ideas in various ways.

The development of the CPS learning model that has been done shows that the CPS learning can maximize the ability of students at the SMP level. The learning process is more interesting so that it raises student activities and learning becomes more directed because the stimulus given by the teacher directs students to be able to complete the task well, and the existence of active discussion in class provides students the opportunity to achieve good mathematical creative thinking skills.

Relevant research related to the effectiveness of CPS learning has been conducted by Budiarti, Y., (2016) that the CPS is one of the effective models to improve students' creative thinking abilities. In line with this, research conducted by Asmawati, E. Y., Rosidin, U., & Abdurrahman (2018) states that there is an effect of the CPS learning model on students' critical thinking skills with a significant increase in student grades. In addition, other research conducted by Wijayanti, S., & Sungkono, J. (2017) shows that the development of learning tools that refer to SAVI-based CPS models is effective. Thus it can be concluded that learning CPS models in terms of learning styles and effective gender.

Based on the gender classification of students obtained data grouping of students listed in Table 2.

Table 2. Grouping Students Based on Gender

Gender	Number of Students	Percentage (%)
Male	21	43.75
Female	27	56.25

After classifying the learning styles based on the data in Table 2, a selection of research subjects is chosen based on their gender. Each subject was chosen by three subjects to determine the achievement of mathematical creative thinking abilities as in Figure 1.

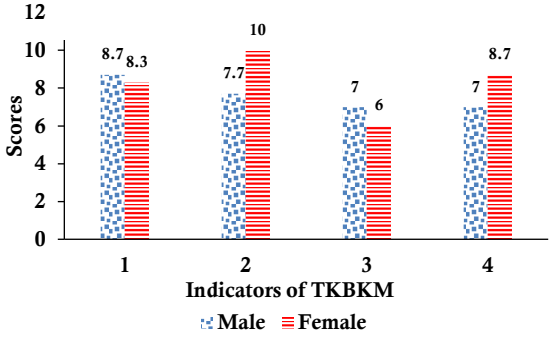

Figure 1. Percentage of Achievement of Mathematical Creative Thinking Aspects

Figure 1 shows that the achievement of indicators of creative thinking ability in male and female students with CPS learning get high scores, but in several indicators seen in figure 1 that male students are superior to female students, as well as female students look superior compared male students on several indicators. The following is a more detailed explanation.

Figure 1 shows that in the first indicator, which is an indicator of fluency, both male and female students get high scores, but male students get higher scores than female students, which means mastery of abilities on the fluency indicators in male students can said to be better than female students. Male students can understand problems well, solve problems correctly and correctly and can provide more than one answer correctly. This is consistent with the results of Benolken's research (in Nur, 2018) which states that male students who have mathematical thinking limitations are better able to use various mathematical attributes in problem solving than female students. Furthermore, Colomeischia (in Nur, 2018) stated in his research that there were differences in the attitudes of male and female students towards mathematics learning. Female students are better able to handle problem solving that is holistic while male students are stronger in analyzing specific problems. Therefore in this study, indicators of fluency were superior to male students because male students were better able to analyze specific problems.

The male students on the second indicator namely the indicators of detail (elaboration) get enough scores while the female students get the maximum score. This shows that mastery of indicators of the detail of female students is better than male students. Female students are able to broaden their ideas in solving problems and describe in detail the process of solving problems well. This is in line with Krutetskii's research (in Kusumawati, 2014) which states that in thinking, female students are superior in accuracy, accuracy, accuracy and inaccuracy. Another case with male students who tend to be less thorough, in a hurry and tend to get things done in a short way.

Male students on the third indicator namely the indicator of authenticity (originality) achieve a higher score than the female students. This shows that mastery of indicators of authenticity of male students is better than female students. Male students are able to come up with their own ideas or ideas. This is consistent with Naafidza's research (2014) which states that male students are categorized as superior in critical thinking to solve mathematical problems compared to female students.

The male students on the fourth indicator, the flexibility indicator, achieved sufficient scores while the female students achieved high scores. This shows that mastery of female students on flexibility indicators is better than male students. Female students are able to provide answers to more than one alternative and correct. This is in line with Stanley's research (in Kusumawati, 2014) which states that girls outnumber boys in verbal thinking and general intelligence. Furthermore, Torrance expresses verbal creativity as the ability to think creatively which

primarily measures fluency, flexibility, and originality in verbal form.

The test result of male students is presented in Figure 2.

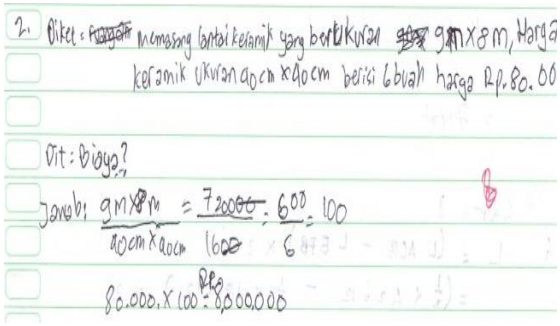

Figure 2. Test Male Student

Based on Figure 2, it can be seen that male subject can develop answers to the problems requested. Subject explains how to answer correctly but subject does not write the area of the room to be installed ceramics, the area of ceramics then the amount of ceramics needed coherent detailed and clear but subject immediately wrote down some calculations without any clear explanation. Even though subject wrote down the cost of ceramic installation requested in the problem correctly. Based on the results of the work of subject, it can be concluded that male subject can solved the problem uncorrectly, they determine the formula correctly and doing the calculation correctly, but write the final answer uncorrectly. The achievement of creative mathematical thinking indicators such as fluency in a very good category, but elaboration, originality and flexibility in a good enough category.

Based on Figure 3, it can be seen that female subject can develop answers to the problems requested. Subject explains how to answer correctly by writing the area of the room to be installed ceramics, the area of ceramics then the amount of ceramics needed coherent detailed and clear. Subject wrote down some calculations with some clear explanation. Subject also wrote down the cost of ceramic installation requested in the problem correctly. Based on the results of the work of subject, it can be concluded that female subject can solved the problem correctly, they determine the formula correctly and doing the calculation correctly.

The test result of male students is presented in Figure 3.

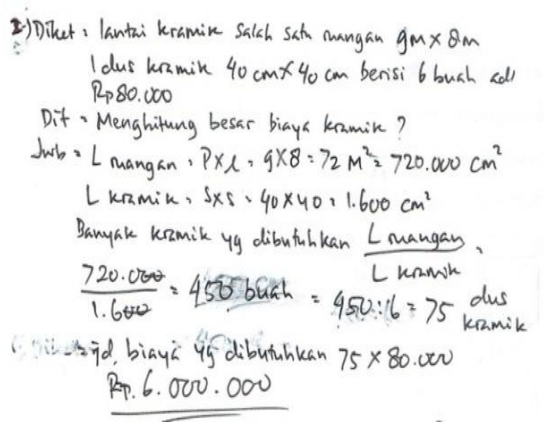

Figure 3. Test Female Students

The achievement of creative mathematical thinking indicators such as fluency and originality in good enough category, elaboration in a very good category, and flexibility in a good category.

CONCLUSION

Based on the discussion it was concluded that quantitative CPS learning can be categorized effectively which is achieving a minimum mastery of 65 and students' achievement reaching the actual completion limit of more than or equal to 75%. And the ability of students to think creatively with CPS learning is more than their ability to think creatively with PBL learning.

Mathematical creative thinking abilities of students in learning with the CPS model can be described as follows. Achievement indicators of fluency and authenticity of male students are better than female students. Mastery of indicators of detail and flexibility of female students is better than male students.

ACKNOWLEDGMENT

The biggest gratitude is given to the Junior High School Bina Amal Boarding School and to the journal reviewers who have advised on

improving the writing and helping the publication of the article.

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