The Effect of Cybernetic Learning Toward Students' Mathematical Creative Thinking

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Abstract. The aim of this research is to analyze the effect of cybernetic learning model toward students' mathematical creative thinking skills. This research conducted at one of junior high school in South Tangerang in the academic year 2017/2018. The method used was quasi-experimental method with randomized control groups posttest only design. Sampling was taken using purposive sampling technique. The result showed that overall, students' mathematical creative thinking skills in the class which is cybernetic learning model applied was higher than students' mathematical creative thinking skills in conventional class. Based on the hypothesis testing with U Mann Whitney test at significant level of 5% it was obtained that the significant level was 0,000 < 0,050. Based on indicators of mathematical creative thinking skills, it showed that the indicators of fluency, flexibility, and elaboration can developed through cybernetic learning model.

Keywords: mathematical creative thinking; cybernetic learning model

1 Introduction

The learning process in the modern era must at least be supported by the competencies needed in the 21st century. In line with this, the National Education Association (NEA) argues there are four abilities that must be possessed in the 21st century known as the "Four Cs", which is one of its capabilities, creativity [1]. Especially in Indonesia, the national education aims to develop the potential of students to be creative people [2]. From the law, it can be concluded that Indonesia has made creative ability as one of the abilities that are the goal of education in Indonesia.

In daily activities, a person will often be faced with decisions that require mathematical abilities. In addition to being creative, students are also expected to be able to think mathematically creative. Mathematical abilities are very diverse. The most important, critical thinking skills and mathematical creative thinking skills are higher than other mathematical abilities. Leikin and Lev [3] stated that there are two creativity in mathematics, general creativity (associated with using problem solving) and specified creativity (refers to creativity in a particular field).

Amid the importance of the ability to think creatively, the level of creativity of the Indonesian people is still relatively low. This was based on the results of The Global Creativity Index survey in 2015 [4] which showed that Indonesia's creativity index was only 0.202. In line with the facts of the survey results, Nurmalianis research in 2014 in one of the state junior high schools [5] showed that students' mathematical creative thinking skills were still relatively low. Only 25.63% of students can think smoothly by giving a lot of answers

ICONQUHAS 2018, October 02-04, Bandung, Indonesia

DOI 10.4108/eai.2-10-2018.2295548

and only 41% of students can provide different solutions. Concern over the low ability of mathematical creative thinking must be immediately followed up. One solution to improve the quality of education is to improve the learning model used.

Cybernetic learning model comes with one of the learning stages, namely using technology [6]. With the use of technologies such as computers as learning media, students are expected to be more active during the learning process. Even in the 2013 curriculum, the use of computers in mathematics learning is one of the basic competencies that students must possess. But the existence of these basic competencies does not necessarily create a computer-based learning process that supports students' creative thinking skills. Based on the results of pre-research interviews that researchers have conducted on one of the mathematics teachers shows that the learning process that occurs in the classroom is only limited to the cultivation of mathematical concepts as usual without using a computer. So that the learning process is still teacher-centered and do not provide a gap for students to think creatively.

In accordance with the previous description, this study aims to examine whether the mathematical creative thinking skills of students who obtain learning using the cybernetic learning model are higher than students who obtain learning using conventional learning models.

1.1 Mathematical Creative Thinking

Mathematical creative thinking is closely related to creativity. General creativity can be seen from two sides, the first is seen from a special way of thinking commonly called divergent thinking and the second can be seen from products that are considered creative [7]. In addition to being seen from the products produced, creativity can also be viewed in terms of the process, namely the process of creative thinking. Creativity is a multi-dimensional construct, consisting of various dimensions, namely cognitive dimensions (creative thinking), affective dimensions (attitudes and personality) and psychomotor dimensions (creative skills) [8]. Creative thinking is the ability to find many possible answers to a problem, where the emphasis is on quantity, usefulness, and diversity of answers [9]. From the many definitions according to some experts, researchers conclude that creative thinking is a process to produce something that is diverse, new, unique, and useful.

Indicators of creative thinking consist of fluency skills, flexibility thinking skills, originality skills, elaboration skills, and evaluation skills [10]. Fluency has characteristics: (1) sparking many ideas, answers, solving problems or questions; (2) provide many ways or suggestions to do various things; (3) always think of more than one answer. Flexibility has the following characteristics: (1) produce various ideas, answers, or questions; (2) seeing problems from different points of view; (3) able to change the way of approach or way of thinking. The characteristics of Originality are (1) being able to give birth to new and unique expressions; (2) thinking of unusual ways to express themselves; (3) able to make unusual combinations of elements. The characteristics of elaboration are (1) able to enrich and develop an idea or product; (2) adding or detailing an object, idea or situation in more detail. The last is the characteristics of Evaluation are (1) determining the benchmark of its own assessment and determining whether the action taken is correct (2) Able to make decisions about open situations; (3) not only spark ideas, but also implement them.

Some experts only cited four characteristics of creative abilities ([8], [9]). In this case, evaluation is not included as a characteristic of creative thinking skills. In this study, the research focused on four indicators of mathematical creative thinking abilities, namely

fluency, flexibility, originality and elaboration. These four indicators are slices of indicators of mathematical creative thinking abilities that have been put forward by some experts.

1.2 Cybernetic learning model

Cybernetic learning model is a learning model that departs from cybernetic theory, some experts call it the term information processing model. This model is based on cognitive learning theory and is oriented to students' ability to process information that can improve their abilities. Cybernetic learning model is a learning model that combines theory and practice [11]. See Fig. 1 for the steps of the cybernetic learning model [6].

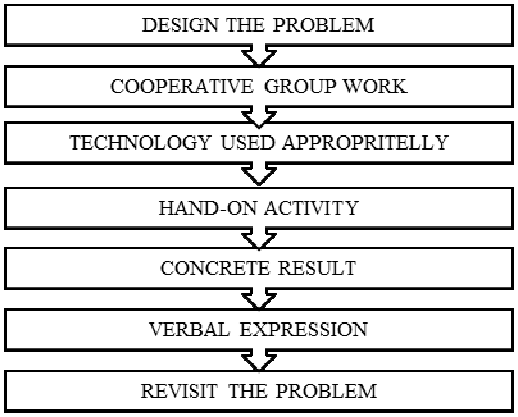

Figure 1. Steps of Cybernetic Learning Model

2 Methods

This research was conducted in one of the junior high schools in South Tangerang. The method used in this study was quasi-experimental with Randomized Control Group Post Test Only research design. The sample involved 86 students divided into two classes, the experimental class taught using the cybernetic learning model and the control class taught using conventional learning models. Sampling was taken with purposive sampling technique. The population in this study were eighth grade students in the odd semester of the 2017/2018 school year. From the population, two classes were chosen as the experimental class with cybernetic learning model and the control class with the conventional learning model, with the same number of students, 43 students. The experimental class and the control class are both given the same posttest as the design (see Table 1).

Table 1. Research Design

Group	Dependent variable	Posttest
Experiment	X	O
Control	-	O

X: Treatment of the cybernetic learning model
O: Posttest of mathematical creative thinking skills

The procedure in this study is (1) determining students as samples in the experimental class and control class; (2) giving different learning processes in both classes; (3) give the same posttest. The instrument used in this study is a posttest consisting of nine items of essay. The researcher then analyzes the results of these posttests to determine whether the students 'mathematical creative thinking skills in the experimental class (cybernetic learning model class) are higher than the students' mathematical creative thinking skills in the control class (conventional learning model). Data analysis of the research conducted was to examine the differences between the two mean groups with SPSS software at a significance level of α = 5%.

3 Results and Discussions

3.1 Descriptive Statistics

Descriptive statistical data of students' mathematical creative thinking skills from the experimental class and control class are presented in Table 2.

Table 2. Descriptive Statistical Data of Students' Mathematical Creative Thinking

Statistic	Cybernetic	Conventional
N	43	43
Ideal Score	27	27
Maximum	27	25
Minimum	18	9
Mean	22,12	18,47
Std.Deviation	2,21	4,33

Based on Table 2, the highest score in the cybernetic class was greater than the highest score in the conventional class even though the difference was only 2 points. Furthermore, the lowest score for the cybernetic class was also greater than the conventional class that is with a difference of 9. In addition, the average score of 43 students in the cybernetic class was higher with a difference of 3.65 compared to the average score of 43 students in the conventional class. So that based on this, it can be interpreted that the highest mathematical creative thinking skills of individuals are in the cybernetic class while the lowest mathematical creative thinking skills of individuals are in the conventional class. In addition, judging from the standard deviation in Table 2, the standard deviation of the cybernetic class is smaller than the standard deviation of the conventional class, it means that the scores of students' mathematical creative thinking skills in the conventional class are more varied and spread to the class average, while the students mathematical creative thinking skills in the cybernetic class tend to cluster. Based on the descriptions of the descriptive statistics data, it can be interpreted that the students' mathematical creative thinking skills in the cybernetic class is higher than the conventional class.

The ability of students' mathematical creative thinking skills in more depth is analyzed based on indicators, namely fluency, flexibility, elaboration and originality. The mathematical creative thinking skills reviewed based on indicators are presented in Table 3 as follows.

Table 3. Mathematical Creative Thinking Based On Indicators

Indicator	Ideal Score	Cybernetic		Conventional	
		Average	%	Average	%
Fluency	6	5,26	87,60	4,81	80,23
Flexibility	9	7,88	87,60	5,79	64,34
Originality	6	3,86	64,34	4,00	66,67
Elaboration	6	5,12	85,27	3,86	64,34
Overall	27	22,12	81,20	18,46	68,90

From Table 3, it can be seen that the students' achievement in the cybernetic class for the fluency indicator is 87.60%, while the conventional class has a smaller percentage of 80.23% with the percentage difference between the cybernetic and conventional classes being 7.37%. In this case, the difference that is not too large indicates that the difference in learning provided has not provided a very significant impact on the fluency indicator. Although it cannot be denied that the average value of the fluency indicator in the cybernetic class is higher than the conventional class.

On the flexibility indicator, the average score of cybernetic class students is 87.60%, while the conventional class has a smaller percentage of 64.34% with a difference of 23.26%. The difference is far greater than the difference in the fluency indicator, so it can be said that the use of cybernetic learning models in the experimental class can improve mathematical creative thinking skills on the flexibility indicator.

In contrast to fluency and flexibility which has a greater percentage of cybernetic classes than conventional classes, on the originality indicator the conventional class percentage is even greater than the cybernetic class with a very small difference of 2.33%. The conventional class achievement on the originality indicator was 66.67% while in the cybernetic class it was 64.34%. It can be interpreted that both the conventional cybernetic class and the class both have capabilities that are quite low on the originality indicator.

On the elaboration indicator, the average score of cybernetic class students is 85.27%, this percentage is at 20.93% with the control class having 64.34% achievement. With a large enough difference, it can be said that the use of cybernetic learning models with cooperative strategies in the experimental class can significantly improve mathematical creative thinking skills on elaboration indicators.

Visually, the average percentage score of students based on indicators of mathematical creative thinking abilities of students in the conventional cybernetic class and class is presented in the bar diagram as follows:

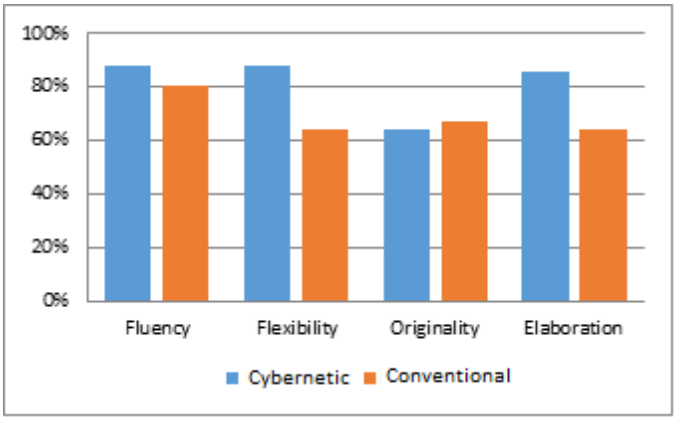

Figure 2. . Diagram of Mathematical Creative Thinking Skills based on Indicators

From the bar diagram in Figure 2, it can be seen that the achievement indicators of mathematical creative thinking with the best level for cybernetic classes are fluency and flexibility indicators because the two indicators have the same percentage size. In the conventional class, the best achievement indicator is fluency. Overall the achievement indicators of cybernetic class with Cybernetic learning with cooperative strategies are higher than conventional classes with conventional learning, although the originality indicators of conventional class outcomes are better than the cybernetic class with a not too significant difference. For significant differences between the conventional cybernetic class and class there are indicators of flexibility and elaboration, so it can be said that the cybernetic learning model has a considerable influence on flexibility and elaboration indicators.

3.2 Hypotheses Testing

Based on the results of the normality test, it was concluded that data from the cybernetic class came from populations that were normally distributed, while the conventional class came from populations that were not normally distributed. Because one class comes from a population that is not normally distributed, the hypothesis testing used in this study is a non-parametric test. The statistical test used is the Mann Whitney test or "U" test for large samples. The results of the calculation of hypothesis testing obtained in this study are presented in the following table:

Table 4. Hypotheses Testing Result

	Score
Mann-Whitney U	423,000
Asymp. Sig. (2-tailed)	,000

In Table 4 above, Mann-Whitney U test statistics are obtained by the price of U = 423 and p-value = 0,000 / 2 = 0 <0.05 or Ho is rejected, so students' mathematical creative thinking abilities in the cybernetics class are higher mathematical creative thinking of students in conventional classes.

3.3 Discussions

The results of the students 'mathematical creative thinking ability test in this study showed a positive influence of the cybernetic learning model on students' mathematical creative thinking abilities. This is in line with the research conducted by Arvyati, La Ode Ahmad Jazuli, Rosdiana, Yoo Eka Yana Kansil, Hasnawati and Kadir Tiya [6], with the conclusion that student learning achievement in linear program material increases using cooperative Cybernetic learning. Some of the differences between the research conducted by Arvyati and this study include the abilities studied, learning material, and learning subjects. In this study the abilities studied were students' mathematical creative thinking skills in statistical material, while the research conducted by Arvyati examined student learning achievement in linear program material. However, although there are some differences, both this study and the research conducted by Arvyati both have a positive influence on learning outcomes.

In this study, after applying Cybernetics learning with cooperative strategies in the experimental class the results showed that students 'mathematical creative thinking skills in the experimental class was higher than the students' skills applied in conventional learning. This is in line with the information processing theory proposed by Rusman relating to Cybernetic learning, that in learning occurs the process of receiving information which is then processed so as to produce output in the form of learning outcomes [12]. Meanwhile, Arikan found that the creativity of mathematics can arise through authentic problems they submit [13]. In this study, the output was more focused on students' mathematical creative thinking abilities. The mathematical creative thinking ability in this study consisted of four indicators, namely fluency, flexibility, originality, and elaboration. Of the four indicators, the cybernetic class looks superior to the conventional class on the indicators of fluency, flexibility, and elaboration. While the conventional class is superior to the cybernetic class only on the originality indicator.

4 Conclusion

Referring to the results of the analysis and discussion, then in the study of the effect of cybernetic learning on students' mathematical creative thinking skills, it was concluded that:

1. Students taught with cybernetic learning models with cooperative strategies have good mathematical creative thinking skills. The best level of indicator of mathematical creative thinking skills is the fluency and flexibility indicator with the same average results, then the elaboration indicator and the lowest is the originality indicator. Cybernetic learning model is effective learning to develop students' creative mathematical thinking skills, especially on indicators of fluency, flexibility and elaboration.
2. Students who are taught by conventional learning have mathematical creative thinking abilities that are quite low. The best level of indicator of mathematical creative thinking skills in this class is the fluency indicator. Indicators of flexibility and elaboration have the same average results. Students who are taught using conventional learning have better fluency abilities compared to other indicators
3. The mathematical creative thinking skills of students taught by Cybernetic learning models is higher than the mathematical creative thinking skills of students taught with conventional learning. Specifically reviewed based on indicators of mathematical creative thinking skills, the results of the study indicate that mathematical creative thinking indicators that can be developed through cybernetic

learning models are indicators of fluency, flexibility and elaboration. The cybernetic learning model has not been able to develop mathematical creative thinking skills in the originality indicator. Cybernetic learning models can develop mathematical creative thinking skills on indicators of fluency, flexibility and elaboration

Acknowledgements. This paper in conjuction with The 4th International Conference on Education in Muslim Society (ICEMS 2018) in Jakarta.

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