RedWhitepress https://series.gci.or.id

Global Conferences Series:
Sciences and Technology (GCSST), Volume 2, 2019
The 1st International Conference on Education, Sciences and Technology
DOI: https://doi.org/10.32698//tech1315152

Integration of Treffinger model to increase students' creative thinking and mathematics problem solving ability: an experimental study on 8th grade students in Gorontalo

S W Dj Pomalato[1]

[1] Universitas Negeri Gorontalo, Indonesia

Abstract. One of the obstacles in achieving optimal results in the learning of science and mathematics is the lack of creative activity conducted in classrooms. Mathematics problem solving needs creativity, in which students can understand the power and benefits of mathematics concepts by themselves. This creative learning environment can be achieved by integrating a creativity-development learning model in the classroom. This study is an experimental study aimed to observe how is the Treffinger model, based on creative-learning model proposed by Treffinger in 1980, can increase students mathematics problem solving, especially for 8th grade students in Gorontalo city. Results show a significant positive effect of Treffinger model in increasing the creative thinking and mathematics problem solving abilities; therefore it can be used to improve mathematics learning outcomes.

Keywords: Treffinger model, creative thinking, mathematics problem solving

1. Introduction

Students' involvement in classroom was the most factors being highlighted in modern mathematics education. Teacher-centric learning activities as found in the old era of mathematics education drive the students lazy and passionless in absorbing the lessons. The biggest defect lies in our educational system itself that hinder the students from being effectively creative in classrooms.

One of the mathematics process skill that needs a board spectrum of creativity is the problem solving. By learning this skill, the students are supposed to understand the power of benefits of mathematical concepts by themselves. By trying to solve math problems, students can develop new knowledge based on their creative experience in that problem solving activity, and then, also by creativity, they can apply and adjust this newly auto-adapted knowledge to build their own strategies to solve real problems in other situations. Therefore, the learning activity in classrooms should be able to conduct students to monitor and reflect their problem solving process using mathematical concepts.

This is a by-model situation. Students can train their creativity if the learning model allows it. The learning model is the backbone of student's creativity development because of the following reasons. First, the learning model is a customizable tool where every teacher has the freedom to select and use

from different models in accordance with the subject being taught. The second reason is the fact that learning model can facilitate students to learn subjects and achieve objectives in various difficulties. Joyce and Weil stated that "each model guides us as we design instruction to help students to achieve various objectives".[1] Even for a mathematics subject with high level of difficulty, students will have no difficulty to understand the subject if the teacher can draw and present a suitable and appealing model. Probably the most important characteristic of this 'suitable and appealing model' is the creative learning environment conducted by the model.

Treffinger, based on his literature study in 1980 on the development of creativity, proposed a model for generating creative learning. A prototype of the model was first introduced in his book titled "Teaching Treffinger Creative Thinking and Problem Solving". In the book, Treffinger confidently assert that the performance of students' creative thinking can be improved and enhanced by orienting the process of learning to creative problem solving. Efforts to teach creative thinking can be done integrally like Torrance and Williams' model,[2] but also can be developed in monolithic, like de Bono model.[3]

Treffinger creativity development models involving two dimensions, namely cognitive and affective, and consists of three stages. The first stage is the development of divergent functions to open the students to new ideas and possibilities. The second stage of the development phase put emphasis on the use of ideas in complex situations with tension and conflict. The third stage is the stage of involvement in the development of a real challenge with an emphasis on the use of the processes of thinking and feeling creatively to solve problems freely and independently.

Reasons for the selection of the Treffinger creative learning model was: (1) the model based on the theory of learning that involves the cognitive processes and effective, (2) efforts to enhance and improve the performance of thinking and being creative is done systematically by focusing on the process of solving the problem, (3) although activities are shown for individual self-development but general learning techniques can be done in groups, and (4), picking materials and methods for Treffinger creativity model can be done in flexible and integrative ways.

Based on the above needs and gaps, this study was conducted to (1) find out the differences in creative thinking ability of students involved in learning mathematics using Treffinger model with those using conventional model based on their class level, (2) to know the difference in mathematical problem-solving skills of students involved in learning mathematics using Treffinger models with those using conventional models viewed by their grade level, (3) to find out differences in creative thinking skills of students involved in learning mathematics using Treffinger model with those using conventional model based on the level of students' ability in mathematics, (4) to know the difference between mathematics problem solving ability of students using Treffinger model with those using conventional model based on the level of student ability in mathematics, and (5) to know the influence of Treffinger model interaction on students' creative thinking ability and problem solving ability.

2. Theoretical Framework

2.1. Conception and creative thinking skills indicators

Talking about the creative thinking process, then the focus of review will be closely related to what is called as creativity. Creativity is the ability to see various possible solutions to problems. Creativity allows people to improve their quality of life. Creativity is not only required in art, literature, or science, but is also found in all areas of life, including mathematics. Discussion of creativity in mathematics is emphasized in the process, namely the process of creative thinking. Therefore, creativity in mathematics is more appropriately termed as creative thinking of mathematics.

The experts define creativity in two ways, namely by convention and conceptually. By convention, the definition of creativity is more on the aspect of creative products in which the level of its quality was judged by an expert observer. In this case, Amabile suggests that a product or a person's response is said to be creative if he or she is considered creative according to the expert or observer who is competent in that field. On the other hand, creativity is conceptually not defined solely by the subjective observations of the experts, but rather based on certain objective criteria. Amabile suggests that a product is considered creative when (a) the product is new, unique, useful, or valuable in terms of particular needs, and (b) is more heuristic, i.e. featuring methods that have never been or rarely done by others before.[4]

Munandar argues that creativity is the ability to create new combinations based on data, information or elements. Creativity is the ability to find many possible answers to a problem, its emphasis on quantity, usefulness and diversity of answers.[5] Anderson assumes that creativity is a process of thinking,[6] while Mednick considers creativity is more like thinking.[7] Thus practically, creativity can be aligned with creative thinking and is a skill that reflects fluency, flexibility and authenticity in thinking, and the ability to elaborate an idea.

Wallas, after seeing Henry Poincare's experience in discovering the Fuchsian or Kekule equations in the process of discovering the structure of the benzene saw a regular pattern occurring in a person when he/she engages in creative thinking. Based on his experience, he expresses the idea that creative problem-solving process takes place through four basic steps, namely the preparation stage, incubation stage, illumination stage, and verification phase. Those who have successfully demonstrated their creative achievement reveal that they experience these four stages of the creative process. Before publishing the theory of chemistry periodical table, Mendeleyev experienced a long incubation period. The discovery of the Funchsian functions by French mathematician Henri Poincare was preceded by an incubation period of days until inspiration came unexpectedly while he was in recreation.[8]

Getzels and Jackson in his study revealed that creative individuals exhibit the following characteristics: a) may be very intelligent and possibly not, although in general they IQ was above average, (b) the correlation between creativity (divergent thinking) and intelligence (especially cognition) are quite low, usually obtained around 0.30, (c) as well as when students are tested both on divergent thinking and cognitive ability, ± 70% of highly creative students (divergent thinking skills above 0.20) are not will be in a high IQ group (cognitive abilities above 0.20).[9] Meanwhile, Ruseffendi states that "although it is difficult to prove that the creative man is better, but especially for himself as a creative child, he will be better able to overcome his life in society later than the uncreative."[10]

Nickerson divides creativity into four components: ability, cognitive style, attitude and strategy. Of the four components of creativity, the component of creative ability is a component that can be used to develop a person's intellect.[11] Getzels and Jackson suggest that some students with high creative ability generally perform tasks equally well with students with high IQ in learning outcome tests.[9] Treffinger also points out that no one has absolutely no creative ability, just as no one has zero intelligence.[2]

Furthermore, Nickerson states that there are three elements related to creative ability: ideational fluency, remote associates, and intuition. In this case, what is meant by ideational fluency is the ability of a person to put forward a number of appropriate ideas quickly and easily. The ideas presented often vary, so sometimes they are called flexibility. Remote associates are a creative ability that occurs with the existence of far-reaching information, while intuition is one's ability to present an idea or idea to solve a problem without realizing it.[11] Furthermore, based on a psychological study, Carin & Sund divides creative abilities in five categories similar to the Parnes' divisions: fluency, flexibility, elaboration, originality and sensitivity.[12]

According to the experts above, fluency is the ability to propose some similar ideas for a problem. Flexibility is the ability to produce several different groups of ideas for a problem. Elaboration is the ability to provide explanations related to creative responses that show how something can be arranged or implemented. Originality is the ability to give a unique response that is different from others. Sensitivity is the ability to generate some ideas in response to a problem. Based on the description of Nickerson and Carin & Sun, it can be argued that ideational fluency equals flexibility, remote association equals elaboration, and intuition equals to authenticity and sensitivity.

From previous description, it is concluded that the creative ability is the ability to designate one's efforts in creativity, find ideas, and find solutions to the problems it faces by using the processes of thinking. Expressing the creative ability by this way will clearly differentiate it from the other abilities that exist in an individual. To observe further, this research divides the components of creativity into 5 abilities; fluency, flexibility, elaboration, authenticity and sensitivity.

2.2. The model of developing creative thinking in mathematics learning

Starting from the assumption that creative thinking is a deliberate process and learning outcome, then learning mathematics, as a deliberate learning process, can be done in the development of creative thinking skills by referring to models that have been done by experts. McPherson identifies models of creative thinking development approaches that can be adopted in learning mathematics: (1) self-development and sensitivity to time, (2) development of cognitive problem-solving skills, (3) understanding of factors that impede creativity and at the same time provide facilitation for improvement and enhancement of creativity, (4) development of innovative ideas, and (5) a combination of the above approaches.[13]

2.3. Application of the problem-solving approach to the study of mathematics

Mathematical problem solving requires the correct concrete steps to achieve the correct answer. John Dewey puts forward five key steps in problem solving: (1) knowing that there are problems, namely awareness of difficulty, despair, wonder or doubt, (2) recognizing problems, i.e. classification and definition, including marking on the intended purpose, (3) using past experience, e.g. relevant information, past problem solving or ideas for formulating hypotheses and problem-solving propositions, (4) testing successively or possible solutions, then reformulate the problem if necessary, and (5) evaluate the decision and draw conclusions based on the available evidence.[14]

3. Methods

3.1. Sample and population

This research was conducted in 8th grade students in Gorontalo, with the consideration that (1) there are some very good topics taught by applying creativity development of Treffinger model, i.e. the concept of time, distance and speed and (2) development of creative thinking ability and math problem solving ability have been done as they studied earlier at the primary school level.

3.2. Design

This study was a quantitative study and uses quasi-experimental research design.

3.3. Operational definition

- Treffinger model in this study is a set of ways and procedures of learning activities developed by researchers based on Treffinger model to encourage the improvement of student creativity, namely the ability to think and creative attitude of students. The learning activities include orientation, self-understanding and grouping, fluency development and flexibility of thinking and being creative, encouraging creative ideas, and developing more realistic and complex problem solving abilities.

- Creative thinking ability is a mathematical score achieved by students in responding to mathematical problems with reference to fluency, flexibility, sensitivity, and detail based on test results provided by the researcher.
- Problem solving abilities are scores that students achieve in solving problems based on the results of tests provided by researchers, where reference mathematical problem solving based on Polya steps.[15]

3.4. Data analysis technique

Data in this research consist of two: (1) data of creative thinking ability of mathematics, and (2) data of problem solving ability of student. The instruments used in this study are descriptive written test (essay) to measure the creative thinking and problem solving ability. The data were analyzed using descriptive and inferential analysis. Descriptive analysis was used to describe raw data of research results, while inferential analysis was used to test the research hypothesis.

4. Result

This study proves that the integration of the Treffinger model in mathematics learning was able to improve students' creative thinking ability and problem solving skills. Hypothesis proved that there is significant difference between the creative thinking ability of students who have been taught using Treffinger model with students' from conventional learning. It was also proved that there is significant difference between the problem-solving ability of students who have been taught using Treffinger model with those using conventional learning.

Table 1. Mean scores between the experimental class and the control class

Student Academic Ability (A)	Treffinger Model (B_1)		Conventional Model (B_2)	
	Creative Thinking Ability (C_1)	Problem Solving Ability (C_2)	Creative Thinking Ability (C_1)	Problem Solving Ability (C_2)
High (A_1)	62.75	77.50	48.40	64.73
Low (A_2)	54.64	60.40	46.38	44.50

Table 1 shows a significant difference between the mean ability of creative thinking and problem solving in the control class and experimental class. Comparison with academic ability also showed significant differences between the two groups. These findings of course indicate that the application of specific strategies in mathematics learning can improve the ability of creative thinking and solving math problems significantly. It was concluded that the integration of creativity development with Treffinger model in mathematics learning is needed in mathematics learning.

5. Discussion

The findings in this study demonstrate the significant benefits of applying the Treffinger model in math learning to improve the creative thinking and problem solving ability in mathematics. These findings are in line with the results from Torrance who developed a learning model using creative problem-solving procedures, where the success in improving the subject's creative thinking ability is about 90% compared to other techniques.[2] These findings give meaning that creative thinking ability and problem solving ability of student mathematics can be developed through learning models based on creativity development, and one of them is Treffinger model.

The role of teachers in applying the Treffinger model is very helpful in achieving learning outcomes. All the teachers involved in this study, especially in the control class, were very enthusiastic and earnest in performing the stages of the Treffinger model. The seriousness of this teacher is so important that it seems that the school level is not a factor influencing the success of learning in improving students' mathematical creative ability. The role of the teacher also greatly influenced the students' attitudes towards and is urgently needed in fostering a positive attitude toward mathematics given the fact that some students still regard mathematics as a frightening subject and should be

avoided. The same thing is also expressed by Ruseffendi that mathematics or exact science for children in general is a subject that is unpopular.[10]
Hypothesis testing also shows that there is a significant correlation between the learning group and students' academic ability to the creative thinking ability of mathematics. This suggests that the creative ability of mathematical thinking is influenced by the interaction of learning groups and their basic academic abilities.

6. References

[1] Joyce B and Marsha W 1992 Models of Teaching (USA: Allyn and Bacon)
[2] Torrance P E 1981 A three-stage model teaching for creative thinking Science Education Information Report, ed A E Lawton (Columbus: The Eric Science, Mathematics and Environmental Education Clearing House) pp 226–253
[3] de Bono E 1983 The Cognitive Research Trust (CoRT) thinking program Thinking: the Expanding Frontier, ed W Maxwell (Philadelphia: The Franklin Institute Press)
[4] Amabile T M 1983 The Social Psychology of Creativity (New York: Springer)
[5] Munandar S C U 1977 Creativity and Education (Dissertation) (Jakarta: Fakultas Psikologi UI)
[6] Anderson A 1970 Biographical correlates of artistic and literarily creativity in adolescent girls Aust. J. Psychol. 18 218–27
[7] Mednick S A 1962 The associative basis of the creative process Psychol. Rev. 69 220–7
[8] Supriadi D 1994 Kreativitas, Kebudayaan & Perkembangan IPTEK (Bandung: Alfabeta)
[9] Getzels J and Jackson P 1962 Creativity and Intelligence: Explorations with Gifted Students (New York: Wiley)
[10] Ruseffendi E T 1991 Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya dalam pengajaran Matematika untuk Meningkatkan CBSA (Bandung: Tarsito)
[11] Nickerson R S, Perkins D N and Smith E E 1985 The Teaching of Thinking (Hillsdale: Lawrence Erlbaum Associate)
[12] Carin A and Sund 1975 Teaching Science Trough Discovery (Ohio: Charles E. Merrill Publishing Co)
[13] McPherson J H 1964 Environment and training for creativity Creativity: Process, and Potential, ed C W Taylor (New York: McGraw-Hill)
[14] Sujono 1988 Pengajaran Matematika untuk Sekolah Menengah (Jakarta: Departemen Pendidikan dan Kebudayaan)
[15] Polya G 1985 How to Solve It. A New Aspect of Mathematical Method, Second Edition (New Jersey: Princeton University Press)