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OPEN-ENDED APPROACH: AN EFFORT IN CULTIVATING STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY AND SELF-ESTEEM IN MATHEMATICS

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Abstract

The present study aims at examining the use of open-ended approach in cultivating senior high school students' mathematical creative thinking ability (MCTA) and self-esteem (SE) in mathematics viewed from school category. The subjects of this research were the students grade XI at three schools; high, middle and low category in Kota Serang, Banten Province. In every school category, two classes were chosen; one class was the experimental group which was taught by open-ended approach, while another class was a control group which was taught by conventional way. This quasi-experimental research employed MCTA test and SE in mathematics scale as the instruments. In general, the research result shows that the MCTA improvement and SE level of the students who are taught by open-ended approach is better than those who are taught conventionally. The results of students' MCTA and SE viewed from school category will be further discussed.

Keywords: mathematical creative thinking ability, self-esteem, open-ended approach

Abstrak

Penelitian ini bertujuan untuk mengkaji pendekatan *open-ended* untuk meningkatkan kemampuan berpikir kreatif matematis (KBKM) dan *self-esteem* (SE) dalam matematika pada siswa SMA ditinjau dari ketagori sekolah. Subjek penelitian ini adalah siswa kelas XI pada tiga sekolah dengan kategori sekolah tinggi, sedang dan rendah di Kota Serang Provinsi Banten. Pada tiap kategori sekolah dipilih dua kelas, satu kelas menjadi kelas eksperimen yang menerapkan pendekatan open-ended, dan satu kelas lainnya sebagai kelas kontrol yang menerapkan pendekatan biasa. Instrumen penelitian kuasi eksperimen ini adalah tes KBKM dan skala SE. Hasil penelitian secara umum menunjukkan peningkatan KBKM dan pencapaian SE siswa yang mendapatkan pembelajaran *open-ended* lebih baik dari pembelajaran biasa. Disajikan juga pembahasan mengenai peningkatan KBKM dan pencapaian SE siswa tersebut ditinjau dari tiap kategori sekolah.

Kata Kunci: kemampuan berpikir kreatif matematis, *self-esteem*, pendekatan *open-ended*

Nowadays, there has been a growing attention towards creativity among educators and researchers. It is due to the fact that the 21st century with its high technology creates numerous basic differences on the way people live. As a consequence, creative people are required to respond these uncertain differences (Piirto, 2011). Creative product on every aspect of life is expected to give solutions to every problems resulted from these differences. Thus, creativity has become one of the essential learning skills on this 21st in many countries in the world to face the fast development of the world (Asia Society Partnership for Global Learning, 2012).

One of the responses made by educators and researchers is by revisiting and revising Bloom taxonomy which is used as the framework of designing curriculum and test by setting 'to create' as the

highest order thinking (Anderson dan Krathwohl, 2001). To create is related to cognitive process which leads students to generate new product or different pattern by organizing several components. By setting creativity as the highest order thinking, it is expected that the students will have ability to solve many unpredictable problems in the future.

In Indonesian context, creativity has also become the focus of learning applied in all subjects, including Mathematics. It is stated in the 2006 Curriculum that Mathematics learning shall give students ability of logical, critical, analytical, critical, and creative thinking (National Education Department, 2006). Furthermore, in the document of 2013 Curriculum, creative thinking is also stated in learning Mathematics (Ministry of Education and Culture, 2013).

Due to its complexities, defining mathematical creativity is not an easy task. Mathematical creativity was simply defined as a choice by Poincare (Sriraman, 2004). In other words, mathematical creativity is characterized by the ability to choose among the combinations which are meaningful and meaningless. Further, Ervynck (1991:47) gives tentative definition on mathematical creativity as:

> …ability to solve problems and/or to develop thinking in structures, taking into account of the peculiar logico-deductive nature of the discipline, and of the fitness of the generated concepts to integrate into the core of what is important in mathematics.

Since those definitions deal with originality and usefulness, the definition of mathematical creativity at a professional level is needed as Sriraman (2005) proposes that mathematical creativity is defined as:

1. The ability to produce original work that significantly extends the body of knowledge (which could also include significant syntheses and extensions of known ideas)
2. The ability to open up avenues of new questions for other mathematicians:
3. The process that results in unusual and/or insightful solution(s) to a given problem or analogous problems
4. The formulation of new questions and/or possibilities that allow an old problem to be regarded from a new angle.

Given the definition of mathematical creativity at the professional level, it can be concluded that mathematical creativity is not only dealing with the ability to solve unusual problem using new perspectives, but also deal with the other mathematicians.

Even though creativity has been the focus of Mathematics learning as stated by curriculum, the classroom implementation of learning which leads to the students' creativity is still far from what it is expected. Fatah (2008) reported that students were not used to open-ended problems as they were only familiar with the problems set in their textbooks or taught by their teachers. Furthermore, there was a tendency that the teachers gave attention more on students learning result instead of its process. As a consequence, students were not able to solve new problems. Syamsuri (2011) also reported that teachers did not implement what has been set in lesson plan which put constructivism in their

classroom. The mathematics learning was dominated by lecturing which then lead the students to be passive. This condition did not make the students more creative as they only listen and solve the problems just as the way the teachers solve the problems.

Besides cognitive aspect, affective aspect is also the focus of learning mathematics in relation with students' mathematical creativity. Self-esteem as one of the affective aspects is believed to give contribution to the students' achievement. Several studies have shown that there is a relationship between self-esteem and learning achievement (Vishalakshi and Yeshodhara, 2012; Harris, 2009; and Branden, 2003).

Cast and Burke (2001) posit that the studies on self-esteem are based on different aspects. , First, self-esteem is viewed as a result or goal. Second, self esteem is considered as self motive. And finaly, self-esteem is seen as a buffer that protects people from bad experience. The present study focuses self-esteem as the goal. Self-esteem is defined as

Coopersmith (Branden, 2003) defines self-esteem as a self evaluation towards his/her own abilities. Further, Coopersmith (Mruk, 2006) states that there are four aspects of self-esteem. They are: a) power which means as an ability to control others, b) significance which means as an acceptance as the result of someone else's evaluation, c) virtue which means the willingness to obey the norms in such a community, d) competence which means ability to reach the goal set by him or herself. The present study focuses on self-esteem on mathematics. Thus, self-esteem in mathematics is defined as the evaluation of someone's ability, experience, competence, influence from others in mathematics.

One of learning approaches that can cultivate students' mathematical creativity is open-ended approach. Open-ended approach based on Shimada and Becker (1997) is believed to give more chances to the students to gain more knowledge, discovery experience, recognize and solve problems as this approach set problems with different methods and more than one solutions. Thus, students will be more active and creative in finding solution of the problems.

The type of problem used in learning with open-ended approach is not routine and open problem. The openness is classified into three types; the process is open, end products are open, and ways to develop are open (Sawada, 1997). Open process means that the task type has several correct ways. Ope n end products mean that the task type has multiple answer possibilities. Finally, open ways to develop means that when the students have solved their previous problems, they can solve new problems by changing the condition of the previous problem.

In Indonesian context, there have been numerous studies on several approaches to enhance students' mathematical creativity (Setiawati, 2014; Suriany, 2013; Aguspinal, 2011; Mahmudi, 2010; Wardani, 2009; dan Pomalato, 2005). However, only a bit studies on the use of open-ended approach in cultivating students' mathematical creativity (Dahlan, 2004). Meanwhile, the studies on affective factors in learning mathematics, especially self-esteem are still rare (Alhadad, 2010). Therefore, the present study aims at examining the use of open-ended approach in cultivating students'

mathematical creativity and self-esteem in mathematics of senior high school students in one of cities in Banten Province, Indonesia.

METHOD

This part reviews how the study is conducted. It consists of research design, research subject, data collecting technique, and data analysis technique.

Research Design

The present study is a quasi-experimental research using non-equivalent control group design as this study cannot fully treat the subjects randomly (Rusefendi, 2005). The selection of the sample is not conducted randomly as it is impossible to create new class. Thus, the existing classes are used.

Research Subjects

The population of the research is the entire senior high school students in Kota Serang, Banten Province. Whereas the sample of the research is the students of senior high school grade XI from three schools at high, middle, and low category in Kota Serang. Further, at every school category, two classes were chosen randomly. The first class was taught by using open-ended approach, while another class was taught by using conventional way.

Data Collecting Technique

The data were collected by using two instruments. They were the test of mathematical creative thinking ability and self-esteem in mathematics scale.

Mathematical Creative Thinking Ability Test

The mathematical creative thinking ability test consists of five items in the form of essays. The material chosen for the test is probability. The test had been checked in terms of face and content validities and reliabilities.

Self-esteem in Mathematics Scale

Self-esteem in mathematics scale was adapted from Reyna (2000). The scale consists of five components; mathematical ability, mathematical experience, attitudes towards mathematics, the other people factor, and self motivation. The scale consists of 30 items in the form of Lickert scale.

Data Analysis Technique

The data from mathematical creativity ability test and students' self esteem were analyzed quantitatively to find out the difference of students mathematical creative ability improvement and self-esteem level between the group which was taught by using open-ended approach and

conventional way. The data were analyzed using two ways ANAVA by considering the data homogeneities and normality. Whereas the data from observation were analyzed qualitatively to support the discussion of the result from mathematical creative ability test and self-esteem in mathematics scale.

RESULT AND DISCUSSION

This part unpacks the result of the study and its discussion which is related to the relevant studies and theories.

The Improvement of Mathematical Creative Ability (MCTA) Viewed from School Level

To find out whether or not an improvement of MCTA viewed from school category, the following hypotheses are proposed:

H_0 : The MCTA improvement of the students who are taught by using open-ended approach is significantly the same as those who are taught by conventional way.

H_a : The MCTA improvement of the students who are taught by using open-ended approach is significantly better than those who are taught by conventional way.

Further, to find out the different improvement of MCTA of every school category the *Mann-Whitney,* t-test and t'-test were conducted as the result of normality test of MCTA at different school category is not normal, and the result of homogenities test of MCTA at different school category is homogenous. The summary of those tests is shown at Table 1.

Table 1. The test of students' MCTA Improvement Viewed from School Category and Learning

School Category	**Learning**	**Rank**	**Value test**	***Sig.***	**H_0**
High	OL : CL	48,08 : 26,33	-4,349	0,000	rejected
Medium	OL : CL	0,429 : 0,297	4,415	0,000	rejected
Low	OL : CL	0,325 : 0,177	4,890	0,000	rejected

OL: Open-ended learning
CL: Conventional learning

Table 1 shows that at every school category, the learning through open-ended approach is significantly better than learning through conventional way. Moreover, to examine the interaction between the learning through open-ended and conventional way and school level towards the improvement of MCTA, the following hypotheses are proposed:

H_0 : There is no interaction between learning and school level towards the improvement of MCTA.

H_a : There is an interaction between learning and school level towards the improvement of MCTA.

To test the hypothesis, two-ways ANAVA test was conducted. Table 2 shows the summary of two-ways ANAVA test result.

Table 2. Two-ways ANAVA test of MCTA based on school category and learning

Source	Score Square	dk	Average square	F	*Sig.*	H_o
Learning	1,134	1	1,134	67,081	0,000	rejected
School category	1,819	2	0,910	53,787	0,000	rejected
Interaction	0,022	2	0,011	0,656	0,520	accepted
Total	34,970	196				

ANAVA test result shown at table 2 at F value = 0,656, the probablity (sig.) is 0,520. Since the probability (sig.) is bigger than 0,05, So H_0 is accepted. It means that there is no interaction between learning and school level towards the improvement of MCTA.

The statistics test on the MCTA data show that the MCTA improvement of the students who learn through open-ended approach is better than that of those who learn through conventional way. This research result is in line with the research conducted by Kwon, et al. (2006) which finds out that the students' divergent thinking who learn through open-ended approach is better than those who learn through conventional way. This is also in line with what has been found by Alhadad (2010) who posits that the implementation of open-ended approach gives the students chance to try to solve the problem with their own understanding, to find various solution alternatives, and to conclude based on their own way of thinking which lead the students' creativity. Further, this research result is also in line with the research done by Mahmudi (2010) about learning through problem based MHM which shows that through the problems which are not routine including open-ended problems can enhance students' MCTA. Further, this research result is also proven what has been stated by several experts who argue that open-ended approach with its openness characteristics will lead the students to think more creatively (Shimada and Becker, 1997; Nohda, 2001; Takahashi, 2005; Kwon et al., 2006).

The Improvement of Students Self-esteem (SE) in Mathematics Viewed from School Level

To find out the students' self-esteem viewed from school category, the following hypotheses are proposed:

H_0 : SE of the students who learn through open-ended approach is significantly the same as that of those who learn through conventional way.

H_a : SE of the students who learn through open-ended approach is significantly better than that of those who learn through conventional way.

Furthermore, as the data were distributed normally and homogenously, t-test was conducted to find out the different level of self-esteem between two different group in every school category. The summary of the t-test result is shown at Table 3.

Table 3
T-test of Students' Self-esteem in Mathematics

School Category	Learning	Comparison of Mean	t	*Sig.*	H_0
High	OL : CL	133,86 : 130,91	2,528	0,014	Rejected
Middle	OL : CL	132,18 : 129,58	2,350	0,022	Rejected
Low	OL : CL	129,64 : 127,20	1,534	0,131	Accepted

OL: Open-ended Learning
CL: Conventional Learning

Table 3 shows that at high and middle school categories, the students' self-esteem in mathematics who learn through open-ended approach is better than those who learn through conventional way. However, at low school category, the students' self-esteem in mathematics who learn through open-ended approach is not better than those who learn through conventional way.

Then, to find out the interaction between learning and school category towards students' self-esteem, the following hypotheses are proposed:

H_0 : There is no significant interaction between learning (*open-ended* and conventional) and school category (high, middle, and low) towards the students' self-esteem in mathematics.

H_a : There is a significant interaction between learning (*open-ended* and conventional) and school category (high, middle, and low) towards the students' self-esteem in mathematics.

To examine the interaction, two-ways ANAVA test was conducted. The result is shown at Table 4.

Table 4. Two-ways ANAVA test of students'self esteem based on learning and school category

Source	Sum of square	dk	Mean square	F	*Sig.*	H_o
Learning	340,115	1	340,115	13,074	0,000	rejected
School level	491,259	2	245,629	9,442	0,000	rejected
Interaction	2,265	2	1,132	0,044	0,957	accepted
Total	3359434,000	196				

Based on Table 4, it can be concluded that learning give significant influence towards the students' self-esteem in mathematics. It is shown by the probability value (sig. = 0,000) which is smaller than 0,05. Moreover, school category gives significant influence towards the students' self-esteem. It is shown by the probability value (*sig.* = 0,000) which is smaller than α (0,05). From ANAVA test result, F value at the interaction is 2,265 with probability value (*sig.*) = 0,957. As it is bigger than 0,05, H_0 is accepted meaning that there is no interaction between learning and school category towards the students' sel-esteem in mathematics.

The statistics data above show that in general, students' self esteem who learn through open-ended approach is better than those who learn through conventional way. It is proven what has been stated by several experts (Branden, 2003; Mujs and Reynold, 2008; Harris, 2009; Vishalakshi dan Yeshodara, 2012) who argue that self-esteem is a dynamic process which can be improved through better treatment in learning. The components of self-esteem; mathematical ability, experience in mathematics, attitude towards mathematics, other people factor and self motivation might be better

increased through appropriate learning approach. Furthermore, this research result is in line with the research done by Alhadad (2010) who finds that open-ended approach can enhance student self-esteem.

CONCLUSION AND SUGGESTION

Learning through open-ended approach can better increase the students' mathematical creative thinking ability despite the different school category. Further, viewed from the school category, the self-esteem of students at high and middle school categories who learn through open-ended approach is better than that of those who learn conventionally. However, at low school category, the self-esteem of the students who learn through open-ended approach is not better than that of those who learn conventionally. It implies that self-esteem is a dynamic process which needs a long process to proceed.

Open-ended approach is effective in cultivating students' mathematical creative thinking ability even at the low school category. However, it is important to take into account the way the teachers help the students to solve the problems by using appropriate scaffolding strategies considering the students' their particular abilities.

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