THE EFFECT OF EXPLORATION APPROACH ON STUDENTS' MATHEMATICAL CREATIVE THINKING ABILITY AND DISPOSITION

Imas Sumartini[1], Utari Sumarmo[2], Asep Kustiana[3]

[1] IKIP Siliwangi, Jl. Terusan Jend. Sudirman Baros
[1] imassuwartini69@gmail.com

Abstract

This article reported the findings of an experiment having a goal to enchance students' mathematical creative thinking ability (MCTA) and disposition (MD) by using exploration approach (EA). Subjects of this research were 60 seventh grade students which selected puposively from 5 classes in a Yunior High School in Garut. The instruments of this research were test of an essay MCTA test, and a MD scale, The research found that the grades of MCTA of students getting treatment with EA were higher than the grades of students taught by scienctific approach (SA), however there was no different grades on student's MD. Beside that, stdudents in both classess still realized some difficulties on solving MCTA tasks, and there was moderate association between student's MCTA and student's MD.

Keywords: Mathematical Creative Thinking Ability, Mathematical Disposition, Exploration Approach

Abstrak

Artikel ini melaporkan temuan eksperimen yang bertujuan untuk meningkatkan kemampuan berpikir kreatif matematis (MCTA) dan disposisi (MD) siswa dengan menggunakan pendekatan eksplorasi (EA). Subjek penelitian ini adalah 60 siswa kelas VII yang diseleksi secara puposif dari 5 kelas di SMP Negeri Garut. Instrumen penelitian ini adalah tes uraian tes MCTA, dan skala MD. Hasil penelitian menemukan bahwa nilai MCTA siswa yang mendapat perlakuan dengan EA lebih tinggi daripada nilai siswa yang diajar dengan pendekatan ilmiah (SA), namun ada tidak ada nilai yang berbeda pada MD siswa. Disamping itu, siswa di kedua kelas masih menyadari beberapa kesulitan dalam menyelesaikan tugas MCTA, dan terdapat hubungan yang moderat antara MCTA siswa dan MD siswa.

Kata Kunci: Kemampuan Berpikir Kreatif Matematis, Disposisi Matematika, Pendekatan Eksplorasi

INTRODUCTION

Basically, mathematical creative thinking ability MCTA) is an interesting learning outcomes that should be possessed by high school students. Some reasons underlying the statement is not only becaused of MCTA is listed in the goal of mathematics teaching (Indonesia Mathematics Curriculum, 2013), namely: to improve student's potency to become creative, accurate, and innovative student but it is in line as well with Pucio & Murdock's opinion (as cited in Costa (Ed.), 2001) that MCTA is a part of life skill needed to solve daily problems, especially in situation of increasingly rapid ICT progress. Some of writers (Martin, 2009, Munandar, 1987, Musbikin, 2006, Pehkonen, 1997) explain creative thinking in different expression, but they have similar components namely: fluency, flexibility,

originality, and elaboration. Munandar (1987) explains in more detail the four components of creative thinking: a. Fluency: to produce a lot of ideas, answers, solutions, or questions; to produce many ways of solution and ideas, perceive things from a different perspective; c Originality: to produce something unique, thinking in unusual way, make unusual combinations; d) Elaboration: to develop and to enrich product; to increase or detail an object, idea, or situation so that became more attractive.

Considering the process contained in MCTA, it can be interpreted that MCTA is classified as HOT in mathematics, so that for solving MCTA tasks students need to have certain positive affective behavior such as having self confidence in learning mathematics, diligently doing mathematical tasks, tends to monitor his own learning and having curiosity in learning mathematics. Polking (as cited in Hendriana, Roahaeti, Sumarmo, 2014) called such positive affective behavior is mathematical disposition (MD).

Indeed, although MCTA is quite difficult and needs to be owned by high school students, but at this time MCTA has not been well mastered by students. This condition were illustrated by the findings of some studies (Moma, Kusumah, Sabandar, Afgani, 2013, Rosyana, Supandi, Ariyanto, 2016, Wardani, Sumarmo, NISHITANI, 2011) which reported that students who taught by ordinary teaching achieved MCTA at low grade qualification. While those students getting treatment with innovative teaching approaches obtained MCTA at moderat to fairly good quality. Meanwhile, some studies (Kartiwi, Sumarmo, Sugandi, 2018, Maya, & Ruqoyyah. 2018, Wardani, Sumarmo, NISHITANI, 2011) reported   that students getting treatment with different teaching approaches obtained mathematical diposition (MD) at prety good grade level.

In teaching-learning mathematics, Polya (1975) argues that the task of teacher is not only to convey the mathematics content, but the more important things are to create learning atmosphere so that encouraged students to present their ideas in their words, and to motivate student to think well. Besides that, Indonesia Mathematics Curriculum, 2013, suggests that mathematics ability and affective behaviour such as MCTA and MD should be improved at the same time. At this time, as has been reported earlier student's MCTA which taught by ordinary teaching approach were not satisfying while students getting treatment with inovative teaching approaches were at good enough qualification. Those findings of student's MCTA and the recommendations of Polya and Curriculum 2013, encourage researchers to find innovative teaching-learning approach that provides opportunities for students to develop MCTA and MD better. Researchers predicted that exploratory approach (ELA) will meet the above expectations.

Exploratory learning approach (ELA))can be defined as an approach that encourages learners to examine and investigate new material with the purpose of discovering relationships between existing background knowledge and unfamiliar content and concepts. This approach is predicted will help children learn through curiosity and inquiry, and student can learn more effective (Verma, 2019).Kartiwi, Sumarmo, Sugandi (2018) reported the advantages ELA than scientific approach (SA) on improving student's MCTA and MD

Those afformentioned arguments and findings motivated researchers to excecute a study to analyze the role of EA, on obtaining student's MCTA and MD, and then we compile research questions as follow.

1. Are MCTA grade and its normalized gain, and MD grade of students getting treatment with exploration learning approach (ELA) better than the grades of students taught by Scientific Approach (SA)?

2. What are student's difficulties on solving MCTA tasks?

3. Is there any association between MCTA and MD?

4. What are students activities during exploration lesson?

In addition to afformentioned arguments have been stated, some writers clarify the term creative thinking in similar meaning to the conception of Munandar as follow. Creative thinking is to compile new relationship from a series of information, to formulate unsual ideas, to create or to produce new solution from existing problems, to pose new questions or new ways (Martin, 2009, Musbikin, 2006). According to Puccio and Murdock (as cited in Costa, ed., 2001), creative thinking consisted of cognitive, affective, and meta-cognitive abilities. The cognitive and meta-cognitive abilities contained some abilities namely: to diferenciate a problem and a probability, to compose excellent and different questions, to discrimininate relevant and irrelevant data, to product many and different ideas, many ideas, and new product or ideas, to examine and to evaluate connection between choices and alternatives, to alter the old of thinking mode and habit, to compose a new connection, to enlarge and to renew a plan or ideas. Those senses of creative thinking ilustrated the flexibility, fluently, and elaboration properties of Munandar's conception of creative thinking.

Other writer, Balka (as cited in Mann, 2005) details mathematical creative thinking into: a) to formulate hypothesis, b) to determine pattern in a mathematical situation; c) to solve a deadlock thinking by propose a new solution (flexibility); d) to propose unusual ideas and to evaluate its effect(originality); e) to identify missing information from a given problem (fluently)); f) to detail general problem into specific sub-problems (elaboration).

As previously reported, mathematical creative thinking ability (MCTA) contains processes that are classified as HOT in mathematics. Implication of that statement is that in completing MCTA assignments it needs to be accompanied by students' strong mathematical disposition (MD). Bandura (1997) emphasizes that MD involves three interrelated processes, namely: self-observation, self-evaluation, and self-reaction. These three processes are part of the metacognition of goal setting in mathematical disposition. Further, Polking as well as Wardani (as cited in Hendriana, Rohaeti, Sumarmo), detail indicator of MD which include: Confidence in doing mathematics, flexible in investigating mathematical ideas, diligently working on mathematical tasks; having interest and curiosity in learning mathematics, tend to minitor their own performance, and having appreciation to the role of mathematics in culture and values, mathematics as a tool, and as a language.

Apart from the study findings that have been reported, a lot of studies   (Aziz, Rochmad, Wijayanti, 2015, Damayanti, Sumarmo, Maya, 2018, Fajriyah & Asiskawati, 2015, Iskandar & Riyanti, 2015,   Rahman & Maslianti, 2015, Rohaeti & Budiyanto, 2014, Rosita, 2016, Rosyana, Supandi, Ariyanto, 2016, Ruhiyat & Sugandi 2017) reported that students getting treatment with different innovative teaching approaches obtained MCTA at medium to prety good   grade level. Nonetheless, some studies (Mulyana, Sumarmo, Kurniawan, 2018, Mulyasari, Rohaeti, Sugandi, 2018, Supiyanto, Hendriana, Maya, 2018, Rijaya, Sumarmo, Kurniawan, 2018, Saomi & Sumarmo, 2018) by implementing various of innovative teaching approaches reported that students attained MD at fairly good grade level.

METHOD
This research was a pretest and postest experiment design having a goal to investigate the role of exploration approach (EA) on student's mathematical creative thinking ability (MCTA) and disposition (MD). The subject of this research was 60 seventh grade students of

two schools determined purposively. The instruments of this research were an essay MCTA test and a MD scale developed specially for this research.

By using Hendriana and Sumarmo (2014) as a guide it was obtained charactristic of MCTA test and SRL scale as attached in Table 1.

Table 1. Characteristics of Instruments of This Study

Test and Scale	n Subyect	n Item Test & Scale	Discriminat power	Difficulty index	Item Validity ($t_{table} = 1.70$)	Relia-bility
MCTA test	30	5	.24 - .49	.66 - .69	.73 - .90	.88
MD Scale	30	30	-	-	1.77 < t < 4.89.....	.79

Data analysis of this survey involved: computation for items scoring for option responses of MD scale, percentage comptutaion, t testing hypothesis of mean difference, χ^2 for testing of existance of association of two variables, and other rational analysis for relevant data. Those data analyzing was used by SPSS.

Apart from that, we also prepare lesson plans and student activity sheets according to characteristics of EA, MCTA and MD. In the following we attached some sample of instruments of this study.

Sample 1. Test of MCTA (fluency)

Given a system linear equations: $2x + 2y = 28$ and $x - y = 4$

Compile a story problem in everyday life from SPLDV above and then solve it.

Sample 2 Test of MCTA (elaboration)

Given a system linear equations $12x - 2by = 12$ and $3ax - by = 6$

Point (2,3) is the solution of the system linear equations.

Determine the value of a and b.

Is there another solution? Explain your answer.

Sample 3 of some items of MD statements are in table 2

Table 2. Items of MD Statements

No.	Statements	SA	S	DA	SDA
1.	I learn liniear inequality of one variable tasks caused I love them.				
2.	I waited for teacher's help when I should (-)				
3.	I check the truth of each step of solutions when I completed linear two variable tasks.				
4.	I first try to evaluate the truth of statements of algebraic forms before asking them to a friend				
5.	I avoid setting the target value of the SPtLSV test to be achieved because it is a burden in learning				

6.   I am challenged to check the correctness of the difficult SPtLSV calculation process.

7.   I'm trying to improve the solution of difficult inequality tasks

8.   I'm sure I can explain to find numbers that meet certain conditions to friends

Note: SA: strongly agree   A: agree   DA: disagree   SDA: strongly disagree

RESULTS AND DISCUSSION

Results

The findings of this research namely student's grades of MCTA, its N(gain) and MD based on teaching approaches were attached in Table 3.

In pre-test there were no different students' grades of MCTA of both teaching approaches, and the grades were at very low level. But afther teaching approaches, the study found that EA took better role than SA on obtaining students' MCTA, its N-Gain, and MD. Student getting treatment with EA obtained MCTA and MD were at prety good grades level. Eventough, student accepting treatment with SA attained MCTA and MD at moderate grades level. Testing hypothesis of those means of MCTA and MD on both teaching approaches were attach ed in Table 4.

Table 3. Student's MCTA and Its Gain (N-G), and Student's SRL In Both Teaching Approaches

Variables	$\bar{x}$ and s	Exploration Approach (EA)				Scientific Approach (SA)			
		Pretes	Postes	$\langle g \rangle$	n	Pretes	Postes	$\langle g \rangle$	n
MCTA	$\bar{x}$	15.53	35.91	.60	32	15.69	30.41	.43	32
	%	31.06	71.82			31.38	60.82		
	s	4.49	5.60	.13		3.72	4.87	.13	
MD	$\bar{x}$		76.67		32		70.53		32
	%		68.75				65.63		
	s		6.69				6.26		

Note:

MCTA: mathematical critical thinking ability   Ideal score: 50

  MD : mathematical disposition   Ideal score:

Table 4. Testing Hypotesis of Mean Difference of Mathematical Creative Ability Its N-Gain, and Mathematical Disposition on the Both Teaching Approcahes

Variables	Teaching approach	$\bar{x}$	SD	n	Sig. (1-tail)	Interpretation
MCTA	Expl. App	35.91	5.60	30		
	SA	30.41	5.60	30	.00 < .05	$MCTA_{EA} > MCTA_{SA}$
N-Gain of	Expl. App	.60	.13	30		$N < MCTA_{EA}$
MCTA	SA	.43	.13	30	.00 < .05	$_n > n < MCTA_{SA}$
	Expl. App	76.67	6.69	30		
MD	SA	70.53	6.26	30	.00 < .05	$MD_{EA} > MD_{SA}$

Note:

MCTA: mathematical critical thinking ability   Ideal score: 50

MD: mathematical disposition   Ideal score: 120

The finding of this research that students' grades on MCTA which at prety good level was similar to the findings of a lot of previous studies (Aziz, Rochmad, Wijayanti, 2015, Damayanti, Sumarmo, Maya, 2018, Fajriyah & Asiskawati, 2015, Iskandar & Riyanti, 2015, Moma, Kusumah, Sabandar, Afgani, 2013, Rosyana, Supandi, Ariyanto, 2016, Rahman & Maslianti, 2015, Rohaeti & Budiyanto, 2014, Rosita, 2016, Rosyana, Supandi, Ariyanto, 2016, Ruhiyat & Sugandi 2017 Wardani, Sumarmo, NISHITANI, 2011) that students getting treatment with various innovative teaching students attained MCTA at fairly good grade level. Different with those findings, this research found student's MD at prety good grade qualification. That finding of student's MCTA grade was similar to findings of a lot of previous studies (Kartiwi, Sumarmo, Sugandi, 2018, Maya, & Ruqoyyah. 2018, Mulyana, Sumarmo, Kurniawan, 2018, Mulyasari, Rohaeti, Sugandi, 2018, Supiyanto, Hendriana, Maya, 2018, Rijaya, Sumarmo, Kurniawan, 2018, Saomi & Sumarmo, 2018, Wardani, Sumarmo, NISHITANI, 2011) that by using variety of innovative teaching approaches students obtained MCTA and MD were at fairly good grades qualification.

Basically, these findings that students' grades on MD were at fairly good level were rational, caused of student's MD behavior has already grew during prior lessons before experiments happened and then student's MD was strengthened during exlporation approach lessons. While student's MCTA grades before experiment (in pretest) were very low level caused of students had not taught yet the new mathematics content and process of MCTA and student's MCTA just improved during exlporation approach lessons. Those findings ilustrated that MCTA tasks were more difficult tasks to solve than to perform MD for seventh grade students.

Further analysis was about student's difficulties on completing MCTA tasks in both teaching approaches were attached in Table 5.

Table 5. Mean Score Of Each Item Of MCTA on Both Teaching Approaches

Teaching approach	Stat.Desc	No.1	No 2.	No.3	No.4	No.5
	Ideal score	10	10	10	10	10
Exploration Aproach	$\bar{x}$	6.09	6.72	8.13	7.56	7.41
	% out of IS	60.9	67.2	81.3	75.6	74.10
SA	$\bar{x}$	5.72	5.44	6.81	6.16	6.28
	% out of IS	57.2	54.4	68,1	61,6	62,8

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The study found that students Exlporation approach did not encountered difficulty in solving MCTA tasks, but students taught by SA still discovered difficulties on determining the number of elements in a particular pattern (flexibility), and in completing an idea so that the problem is solved (elaboration) of MCTA tasks.

In next analysis, by using statistic Pearson-Chi Square (χ^2) and contigency table, the research found that $\chi^2 = .659$ sig(2-tailed), or $\chi^2 = .329$ sig (1-tailed) $> .05$ (Table 5). It meant that there was no association between MCTA and MD. This finding was different with other studies findings (Kartiwi, et.all, 2018, Maya, & Ruqoyyah. 2018, Mulyana, et.all, 2018, Mulyasari, et.all , 2018, Saepul et. all, 2019, Supiyanto, Hendriana, Maya, 2018, Rijaya, Sumarmo, Kurniawan, 2018, Saomi & Sumarmo, 2018, Wardani, et.all. 2011) that there were association between MCTA and variety of mathematical softskills.

Table 6. Test of Pearson-Chi Square and Contigency Coefficient Between MCTA and MD

Pearson-Chi Square (χ^2)	DF	Contigency Cofficient (C)	Sig.(2-tailed)
Pearson Chi-Square	2.418[a]	4	.659
Likelihood Ratio	10.048	4	.040
Linear-by-Linear Association	4.410	1	.036
N of Valid Cases	32		

Discussion

The study found that during EA lessons, students performed active activities such as in the following figures (Figure 1, Figure 2, Figure 3).

teacher's question in EA Class

Figure 2
Students listened actively to friends'explanation in their small group discussion in EA Class

work in front of the class

CONCLUSION

Based on findings and discussion, the research   derived conclusion as follow. The first conclussion was that exploration approach (EA)took better role than Scientific Approach (SA) on improving students' mathematical creative thinking ability (MCTA,) its gain, and   on students' mathematical disposition (MD). However the students' MCTA   were still at low grade level, while students' grades on MD were at moderatw-prety good level. Beside that, some students on scientific approache class experienced difficulties in determining the number of elements in a particular pattern (flexibility), and in completing an idea so that the problem is solved (elaboration) of MCTA tasks. The other conclusion were that, there was no association between MCTA and MD and students peformed active learning in all phases of exploration approach.

The students' grade on MCTA in both classes were at low grade level. It might be students not master yet prerequisite of mathematical process and content included in MCTA tasks. So, before teacher are going to explain a new mathematics topics or content or to conduct study on other mathematical HOT ability, it is suggested to examine students' abilities on its prerequisite firstly. Besides that, students should be motivated to select and to solve more exercises MCTA tasks by themselfes. In order students attained MCTA meaningfully, it is also suggested students asked to write the formulas and rules which used on each step in solving the problems as well.

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