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MATHEMATICAL PROBLEM SOLVING AND DISPOSITION: Experiment with Tenth Grade Student Using MEAs

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Abstract

This reseach is a pre test-post test experimental control group design having a goal to examine the role of Model Eliciting Activities (MEAs) approach, on student's mathematical problem solving ability (MPSA) and disposition (MD). The research involved 59 tenth grade students of a Senior High School in Garut Inodonesia, a MPSA test, and a MD scale. The research found MEAs took greater role than SA on improving student's MPSA and its N<Gain>. Students getting treatment with MEAs obtained MPSA higher grade than the grade of students taught by SA, however those both grades were at low grade level, and students encountered many difficulties on solving MPSA tasks. In addition to, there were no different grades on student's MD, and the grades were at fairly good level, and there was strong association between MPSA and MD. Other findings was that students declared positive opinion on MEAs and they peformed active learning during the lessons.

Keywords:mathematical problem solving, disposition, MEAs approach

Abstrak

Penelitian ini adalah desain kelompok kontrol eksperimen pretest-posttest yang memiliki tujuan untuk menguji peran Model Eliciting Activities (MEAs) pada kemampuan pemecahan masalah matematika siswa (MPSA) dan disposisi matematik (MD). Penelitian ini melibatkan 59 siswa kelas X, tes MPSA dan skala DM. Penelitian ini menemukan bahwa semua siswa berada pada tahap operasional konkret, sehingga kami tidak dapat menganalisis peran tahap kognitif siswa pada MPSA dan DM. Temuan lainnya adalah bahwa MEAs mengambil peran lebih besar daripada SA dalam meningkatkan MPSA siswa dan N <Gain>, pada siswa MPSA yang mendapatkan pengobatan dengan MEAs berada pada tingkat kelas yang cukup baik sementara siswa yang diajarkan oleh SA memperoleh MPSA pada tingkat kelas menengah. siswa kelompok pertama mengalami beberapa kesulitan, sementara siswa kelompok kedua menghadapi lebih banyak kesulitan dalam menyelesaikan tugas-tugas MPSA. Namun tidak ada nilai yang berbeda pada MD siswa, kedua nilai berada pada tingkat yang cukup baik, dan tidak ada asosiasi antara MPSA dan MD. Temuan lain adalah bahwa kelompok pertama dan siswa kelompok kedua menyatakan pendapat positif pada MEAs dan PBL, dan mereka melakukan pembelajaran aktif selama pelajaran.

Kata Kunci : pemecahan masalah matematik, disposisi, pendekatan MEAs.

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INTRODUCTION

Based on our experience of visiting Senior High School in Garut in 2018, we get an interesting impression (Mahmudin, Ratna, Susilawati, Reni, Mulyana, Mellyana, 2018). Overall, students were accustomed and pleasured to learn in small group discussion (Figure 1). They performed active learning to solve problems about the matrix and determinant. Even, they were pleasured to present their work in front of the class voluntarily (Figure 2). However, few students encountered difficulties in understanding the problem and they wait for the teacher's help. (Figure 3).

Figure 1. Students actively solved problem of matrix and diterminant

Figure 2. Students presented their work in front of the class voluntary

Figure 3. Students encountered difficulty and asked for teacher's help

Student's difficulties in solving non-rutin mathematics problem were found as well in some studies (Hendriana, Johanto, Sumarmo, 2018, Pujiastuti, Kusumah, Sumarmo, Afgani, 2014, Romlah, Sumarmo, Syaban, 2018) that students taught by ordinary teaching attained mathematical problem-solving ability (MPSA) at low-grade qualification, while students getting treatment with innovative teaching obtained MCTA at medium-pretty good grade level. While those positive student's learning behavior was by findings of some earlier studies (Hanifah, Mirna, Mulianty, Fitriani, 2018, Rubaitun, 2018, Kartiwi, Sumarmo, Sugandi, 2018) that students getting treatment with different teaching approaches obtained mathematical disposition at pretty good grade level. Those findings pointed out that to complete the MPSA task was more difficult to perform a good mathematical disposition (MD).

Bassically,MPSA is an essential mathematical ability that should be mastered by and improved on high school students. The reasons that grounded to the statement are: Beside MPS is attached in the goal of mathematics teaching (Indonesia Mathematics Curriculum 2013, NCTM, 2000), there is a well-known statement that is: MPSA is the main mathematics ability in learning mathematics, even if it is the hart of mathematics teaching (Branca, 2005, as cited in Hendriana, Rohaeti, Sumarmo, 2017). Some authors define MPSA in different notions, but they have a similar meaning. Those definition among other are a) MPSA is a difficult problem or task that it has no certain algorithm for attaining the solution (Polya,

1985); b) MPSA is a process of implementing previous knowledge, skill, and insight for completing unknown condition problem (Krulik and Rudnik, 1995).

To pay attention deeply to those mathematical processes involved in solving the MPSA task, it describes that MPSA consists of higher-order thinking (HOT) skill in mathematics. As an implication of that statement, for solving MPSA tasks, besides students should master the mathematics contents, students should have a strong disposition on carrying out the MPSA tasks, students should possess cognitive readiness learning. Polking (1998, as cited in Sumarmo, 2010, Hendriana dan Sumarmo, 2014) calls that the strong desire in mathematics as a mathematical disposition (MD), and the cognitive readiness learning as formal reasoning ability.

Regarding mathematics teaching and learning, the 2013 Mathematics Curriculum of Indonesia suggests mathematical hard-skill and soft skills such as MPSA and MD should be improved run together. Besides that, Polya (1975) proposes that teacher's role is not merely to deliver mathematical content, but the more important thing are: to behave as a student's wish, to appreciate student's thinking, to help the student to construct their new knowledge and to expand student's thinking ability, to motivate a student to think on his way and to create a situation for students to learn better. Those suggestions motivate researchers to select a kind of innovative mathematics teaching for improving student's MPSA and MD run together. Researchers argue that MEAs will give opportunities to students for enhancing student's MPSA and MD during the lesson.

Chamberlin and Moon, (2005, 2008) and Lesh (as cited in Permana, 2010) clarify that MEAs is an approach in which students work in a small group for understanding, clarifying, and communicating mathematics concepts by using a mathematical model. Further, they propose five learning activities in MEAs, such as a. Collaboration; b. Multiple processes; c. Self-directed learning and self-assessment; d. Fastening of ownership; and e. Model development. Some studies reported the advantages of MEAs on improving students' MPSA (Permana, 2010, Rubaitun, 2018, Wahyuningrum, 2014) and on mathematical critical thinking (Hanifah, Mirna, Mulianty, Fitriani, 2018)

The aforementioned arguments and findings motivated researches to research enhancing student's MPSA and MD by using the MEAS approach and we pose research questions as follows.

1. What are the student's percentage on each cognitive stage measured by using TOLT?
2. Are MPSA grade and its normalized gain, and MD grade of students getting treatment with MEAS better than the grades of students taught by SA?
3. What are the student's difficulties in solving MPSA tasks?
4. Is there any association between MPSA and MD?
5. What are student's activities during MEAs and SA lessons**?**

In addition to the explanation of MPSA that has been described previously, MPSA is non-rutine mathematics problem which had no rules or principles for solving it (Hudoyo, 1998). Observed from the traits of the problem, then Yee (2005) proposed two kind of problems namely: a) closed problem or well-structured problem that is clear problem which has one true solution; b) open-ended problem or ill-structured problem that is unclear problem or uncomplete information and aroused many ways to solve it.

From other point of view, Polya (1985) propose some steps of MPSA, those were : a) First, to understand the problem namely to identify the known and unknown data and to examine the sufficiency data for solving problem; b) To formulate mathematical model of the problem; c) To seek strategy, to elaborate, and to excecute enumeration of the mathematical model; d) To examine the truth of the solution. Further, Polya (1985) suggests some strategies for solving MPSA task such as: to pose simpler problem, to compile table, to invent pattern, to detail the main problem into sub-problems, to excecute enumeration, to think logically, to back-ward, and to neglect imposible matter. Other authors, Muijs and Reynolds (2005) proposed some suggestion in solving problem those are: connecting, modelling, scaffolding, coaching, articulation, and reflection.

To consider the kind of activities or processes involved on MPSA, they ilustrated that MPSA is classified as high order thinking (HOT) mathematics skill. That statement implies that for excecuting MPSA tasks, student should have a strong desire to do it. Such strong desire is part of mathematical disposition (MD). Polking (as cited in Sumarmo, 2010, Hendriana & Sumarmo, 2014) detail indicators of MD as follow: a. To possess self confidence in solving mathematical problems; to give reasons and communicating mathematical ideas; b. To be flexible looking for alternatives; c. To be diligent in doing mathematics; d. To show interest, curiuosity in completing mathematical tasks; e. To tend to monitor their own reasoning; f.To assess mathematics in other situations and everyday problems; g. To appreciate the role of mathematics in culture and values.

Carreira (2001) elaborates some steps in executing model-eliciting activities as follow:1. Students identified and simplified a real problem, and then they compiled mathematics model, solved it, and interpretated the solution; 2. Students defined the variables, made notation, and identified some forms and mathematical structure, drew a graph, or wrote an equation, and formulated mathematical model; 3. Students analyzed and manipulated the mathemtical model (in Step 2) and then they solved it. In a case that the model couldn't be solved, the students needed to simplify the model; 4. Students examined the truth of solution toward the initial situation. When the model was tested, it was called the mathematical model as powerful model.

MEAs approach has some advantages such as: a. The approach was a real and related to contextual daily life; b. Students able to contruct a knowlege based on realistic problem; c. Students created a pattern in their cognitive structure for solving the problem; d. Students identified, evaluated, and reviewed their thinking; e. Students could share ideas with other students to solve the problem; f. Students improved their learning activities in small group discussion. Besides those advantages, MEAs had some disadvantages, namely: a. It was difficult to compile meaningful problem for students; b. It was difficult to pose problem could be solved directly; c. The difficult problem made students sick and tired.

Besides afformentioned findings of studies we had reported, there were some other relevant research's findings such as follow. Some other studies (Hanifah, Mirna, Mulianty, Fitriani, 2018, Sumarmo, Suharyati, Maya, 2018) reported the advantages of MEAs on improving student's mathematical critical thinking ability and Other rstudies (Hidayat, Sabandar, Syaban, 2018, Krismayanti, Sumarmo, Maya, 2018, Mulyana, Sumarmo, Kurniawan., 2018, Romlah, Sumarmo, Syaban, 2019, Saomi, Sumarmo, 2018, Yusniawati, Hendriana, Maya, 2018) by using variety of teaching approaches reported that students obtained MPSA at fairly-good grade level. As well as, other research (Saomi, Sumarmo, 2018, Supiyanto, Hendriana, Maya, 2018, Sumarmo. Kusnadi, Maya, 2018, Yonandi & Sumarmo, 2012,

Yusniawati, Hendriana, Maya., 2018) by implementing variety learning approaches they found that students reached MD at fairly good grade level.

METHOD

The goal of this research is to analyze the role of the Model Eliciting Activities (MEAs) Approach on students' mathematical problem-solving ability (MPSA) and disposition in mathematics (DM). This experiment took pre-test-post test experimental design with subject sample were 59 tenth grade students. The instruments of this research were TOLT, an essay MPSA test, and a DM Likert form scale. Except for TOLT which is directly adopted from Tobin and Capie (as cited in Sumarmo, 2019) other instruments were compiled for this research specifically. MPSA test consisted of 5 items, and the DM scale consisted of 30 items that were compiled on a Likert form scale. Before we implemented the instruments, we tried-out them to students who have learned the mathematics content of the MPSA test. Then, by using Hendriana and Sumarmo (2014) and Sumarmo (2015) as references we obtained a description of the MPSA test and DM scale as listed in Table 1.

Table 1. Description of MPSA test and DM Scale

Instruments	n Subyect	n Instrument	Reliability	Item Validity	Difficulty Index	Discriminat Power
MPSA test	59	5	.72	.68-.75	.36- .48	.22- .44
MD scale	59	30	.913		-	-

In the following, we attached sample item of MPSA test, and sample statement of MD scale.

Sample 1. Item Test of Mathematical Problem Solving

Andi stands on upper strorey of a building with certain height. He observes a truck moves with contant velocity to go menuju base floor with depession angle is α, where $\tan \alpha = 1$. After 10 minutes, then the trcuk is seen with depresi angle is β with $\tan \beta = 5$. Andi will cakulate the time need for the truck reached basemen of the tower.

a. Scetch the situation, and write the known data and asked data;
b. Compile a mathematics model of the problem, and write concept involve in the model.
c. Elaborate the strategy of solving the problem and solve the model and write process or rules used in each step of the enumeration.
d. Examine the truth of the obtained solution

Tabel 2. Sample 2**:** Item of Mathematical Dispostion Scale

No.	Activity, feeling, or opinion	QO	O	S	QS
1.	Feel to be affraid when teacher asks to solve trigonometry problem in the front of the class.				
2.	To sellect intentionally excersices to give reason in solving trigonomtry problem for strengthen comprehension.				

3.	Like to solve trigonomtri problem in different ways even it need more time.
4.	Give up when realize difficult trigonometry identity problem.
5.	Feel to be challenged to try a new way in solving trigonometry problem even it need to learn hard.
6.	Examine once again mathematics tasks had already solved .

Note : QO: quiet often ; O: often; S: seldom; QS: quiet seldom.

RESULTS AND DISCUSSION

Result

Description of students' mathematical problem solving (MPSA) and students' disposition in mathematics (MD) in both teaching approaches were attached in Table 3. Based on data in Table 2, the research found that in the pre-test there was no different grades of MPSA between students getting treatment with MEAs approach and students taught by Scientific Approach (SA), and the grades were at low level. However after teaching-learning process students getting treatment with MEAs approach obtained higher grades on MPS, on its gain (N<G> MPSA), and on MD than the grades of students taught by SA.

Table 3. Description of Students' Mathematical Problem Solving and Students' Disposition in Mathematics in both Teaching Approaches

Variable	Stat.	Model Eliciting Activities (MEAs) Approach				Scientific Approach			
		Pretest	Postest	N<G>	n	Pretest	Postest	N<G>	n
MPSA (IS= 62)	$\overline{X}$	28.67	34.73	.20	30	26.87	31.03	.14	29
	% IS	46.24	56.02	-		43.34	50.05	-	
	SD	8.41	9.14	.14		48.18	9.28	.13	
DM (IS=120)	$\overline{X}$		88.6		30		81.76		29
	% IS		73.83				68.13		
	SD		9.77				10.66		

Note : MPSA : Mathematical problem solving ability (Ideal Score : 62)
DM : Disposition in mathematics (Ideal Score : 120)

The first group of students reached MPSA at almost moderat grade level, while the second group of students obtained MPSA at low grade level. Regarding students who received MEAs approach reached better grade on DM than the grade of students taught by SA, the grades of DM of students in both classes were classified at prety good level. Testing hypothesis of mean difference of students' grades on MPSA between students getting treatment with MEAs approach and students taught by SA were attached in Table 4.

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

Variable	Teaching approach	$\bar{x}$	SD	n	Sig.	Interpretation
MPSa	MEAs	34.73	9.14	30	.00 < .05	$MPSA_{MEAs-SA} > MPSA_{SA}$
	SA	31.03	9.28	29		
N-Gain of	MEAs	.20	.13	30	.00 < .05	N-Gain $MPS_{MEAs-SA}$ >
MPS	SA	.14	.13	29		N-Gain $MPSA_{SA}$
	MEAs	88.6	9.76	30		
DM	SA	81.75	10.65	29	.00 < .05	$DM_{MEAs-SA} > DM_{SA}$

Note : MPSA : Mathematical problem solving ability (Ideal score MPS: 62)

DM : Disposition in mathematics (Ideal score DM :120)

Further analysis was about students' difficulty on solving MPSA tasks. That information could derived from data in Table 5 about student's grade on each item of MPSA test.

Table 5. Mean Score of Each Item of Mathematical Problem Solving Ability Test of students In Both Teaching Approaches

Teaching approach	Stat.Desc	No.1	No 2.	No.3	No.4	No.5	Total
	Ideal score	14	10	12	14	12	62
MEAs approach	$\bar{\bar{x}}$	7.20	5.67	6.30	8.47	7.10	34.73
	% out of IS	51.42	56.70	52.50	60.50	59.17	56.02
SA	$\bar{x}$	6.28	5.17	6.24	6.89	6.45	31.03
	% out of IS	44.86	51.70	52.00	49.21	53.75	50.05

Analysis data about association between MPSA and MD, was carried out by using contigency table and statistics Pearson-Chi Square (χ^2). The research found that χ^2 = 60,000[a], with asymp-Sig (2-sided) was .000, df = (3-1)(3-1) = 4 and compared to χ^2_{table} = 9.488. and C = .803 or Q = .984. Becaused of $\chi^2_{calculate} > \chi^2_{table}$ namely 60,000[a] > 9.488, it concluded that there was a very high associstion between MPSA and DM. (Table 6)

Table 6. Contingency between Mathematical Problem Solving Ability (MPSA) and Mathematical Disposition (MD)

MPSA \ MD	High	Medium	Low	Total
High	8	0	0	8
Medium	0	14	0	14
Low	0	0	8	8
Total	8	14	8	30

Discussion

Finding of this research that students obtained MPSA at low-moderat grade level was different with fingdings of previous studies (Hendriana, Johanto, and Sumarmo, 2018, Hidayat, Sabandar, Syaban, 2018, Krismayanti, Sumarmo, Maya, 2018, Maya & Ruqoyah, 2018, Permana, 2010, Rubiatun, 2018, Pujiastuti, et.all, 2014) that by using various innovative teaching approaches reported that students attained MPSA at fairly good grade level. However, the findings of this research that students in both classes achieved DM at prety-good grade level were similar to the findings of previous studies (Hanifah, Mirna, Mulianty, Fitriani, 2018, Kartiwi, Sumarmo, Sugandi, 2018, Krismayanti, Sumarmo, Maya, 2018, Mulyana, Sumarmo, Kurniawan., 2018, Rubaitun, 2018, Saomi, Sumarmo, 2018, Sumarmo. Kusnadi, Maya, 2018, Supiyanto, Hendriana, Maya, 2018,. Yonandi & Sumarmo, 2012, Yusniawati, Hendriana, Maya., 2018) thay by implementing variety of teaching approaches students obtained DM at prety good grade level.

From Table 5 the research found that students getting treatment with MEAs met many difficulties in solving almost items of MPSA tasks. Even, students taught by SA encountered difficulties in all items of MPSA tasks. This finding was similar to finding of a previous research (Romlah, Sumarmo, Syaban 2018) that students obtained MPSA at low grade level and students still encountered many difficulties in solving MPSA.

This finding was similar to finding of previous research (Hendriana, Johanto, Sumarmo, 2017, Sumarmo, Suharyati, Maya, 2018) which reported there were association between mathematical hardskill and softskill). However, this research finding was different with fidings of other previous research (Romlah, Sumarmo, Syaban, 2018) that they detected no association between MPSA and habits of mind. Those findings ilustrated that excistency of association between mathematical hardskill and softskill were inconsistent.

Next analysis was about students activities during MEAs lessons. Students showed good performance and participated in learning with enthusiasm, they work together to identify the problem actively (Figure 1), they formulate and solve problem carefully (Figure 2), they pose question when teacher observed student to work (Figure 3), and students present their conclussion about mathematics has been learned (Figure 4

Figure 1. Students identify Problem on their work sheet actively

Figure 2. Students formulate and solve problem enthutiastically

Figure 3. Students collect data and then pose open-ended questions

Figure 4. Students present their group work in front of the class voluntarily

Moreover, st with the new accepted teaching approach (MEAs) appı e confused to solve new kind mathematics problems. In this research, sometimes teacher faced some obstacles in conducting MEAs, such as limitted allocated time whereas MEAs needed more time for students to construct their knowledge, to discuss in their group, and to derive conclussion. Eventhough, in further sessions the troubles could be handled by offering more interesting mathematics task and guidance during students working together in each small group.

CONCLUSION

Based on research finding and discussion, the research derived some conclusion as follow. Model Eliciting Activities (MEAs-SA) took a better role than SA on improving students' mathematical problem-solving ability (MPSA), it's gain N<G> MPSA, and disposition in mathematics (DM) as well. However, the grades of MPSA of students getting treatment with MEAs and students taught by SA were still at a low-grade level. Students in both classes encountered difficulties in many items of MPSA tasks. Different from the low grade of students' MPSA, students of both teaching approaches attained DM at pretty good grade level.

In the other conclusion, there was a very high association between MPSA and DM. In addition, students performed more active learning during MEAs than during SA lessons, however, students' activities during MEAs had not conducted yet for students to obtain MPSA at good grade level. For students to master MPSA better especially on solving non-routine mathematics open-ended problems, students should be motivated to compile or to select open-ended problems and to solve the problems and remind students for familiarizing themselves to write concepts, principles, and or rules involved in each step of completion.

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