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THE IMPLEMENTATION OF MEAs INSTRUCTION TO STUDENTS' MATHEMATICS PROBLEM SOLVING AND CONNECTING ABILITY

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Abstract

This study is a part of research report entitled "Developing Senior High Students' Mathematic Power and Emotional Intelligence and Their Retention by MEAs Instruction". This study is an experiment applying pretest-posttest group design which aims at analyzing the effect of MEAs instruction towards senior high students' mathematics problem solving and connecting ability. Besides, this research is also expected to be able to improve their mathematics problem solving and connecting ability. The population is all eleventh graders of senior high schools in Cimahi, while the sample is purposively chosen from two senior high schools in Cimahi and randomly selected from existing grade XI. Then they are randomly selected to become experiment group and control group. Based on the result, it can be concluded that: (1) students' problem solving ability with MEAs instruction is better than those with conventional instruction. Both classes' ability is Fair. (2) Students' connecting ability with MEAs instruction is better than those with conventional instruction. The ability of experiment class is Good; while control group is Fair. (3) There is a fairly strong level of association between students' problem solving and connecting abilities.

Key words: *MEAs, Problem Solving, Connection*

INTRODUCTION

The basic mathematical abilities that students need to have are problem solving, reasoning, communication, connection and representation. This was implied in NCTM (Irwandi, 2012) stating that being able to comprehend and apply mathematics means possesing mathematical power consisting of exploration, reasoning, problem solving, communication, connection, and other intellectual abilities. As formulated by KTSP (School-Based Curriculum) in 2006 (Depdiknas, 2006) stating that mathematical instruction aims at: a) understanding mathematical concepts, explaining and applying relationship of concepts or algorithm flexibly, accurately, efficiently, and precisely in solving problems, (b) reasoning on pattern and character, using mathemical manipulation in making generalization, collecting evidences, and explaining mathematical ideas and statement, (c) doing problem-solving consisting of the capability of understanding problems, designing mathematical models, finishing models, and interpreting solutions that have been made, d) communicating ideas by symbols, tabel, chart and other media used for clarifying condition and problems, and (e) respecting mathematical benefits in daily life by improving curiousity, caring, interest in studying mathematics, having determination and confidence in solving problems.

The purpose of education is essentially a continuous process to address the problems faced. Mathematical problems are solved by high mathematical power so that the problems can

be resolved properly. Yuan (2013) explains that the problem is not the subject, but what is given more emphasis is the method in solution. Polya, in his book, wrote a guidance of solving the problems by using the formula consisting of *See* (see), *Plan* (the plan), *Do* (working on), and *Check* (re-check). Subsequently, the ability to reasoning is essential in understanding mathematics. Mathematical connection which is also important is the application of mathematics in everyday life that presents a synopsis to connect a topic with other mathematical topics. According to Sumarmo (2005), the ability of students' mathematical connections can be seen from the following indicators: a) recognizing equivalent representations of the same concept, b) recognizing the connection of mathematical procedure of a representation to the equivalent representation procedure, c) using and assessing the interrelation of mathematical topics and interconnection beyond mathematics, and d) using mathematics in everyday life. In the indicator of mathematical connection, it is obviously explained that the ability of making representation is also necessary to connect mathematical problems. This is supported by Hwang, *et.,al* (2007) stating that representation varieties which are frequently used in communicating mathematics include: tables, images, graphics, mathematical propositions, written texts, and the combination of all of them. While Elia (2007) classifies representation to be: verbal, images, concrete objects, tables, manipulative models and the combincation of all of them.

To achieve these objectives as mentioned, the question to emerge is "how does the instruction improve the ability of problem solving, reasoning, connecting, and representing? How this question is answered depends on our beliefs about the learning process (Sanjaya, 2006). In related to the learning process, the teacher's role is very important in developing the students' ability to think. As Polya mentioned (Yuan, 2013), that the teacher does not only provide information but also place himself due to the condition of students, understand what is going in their mind, and then help them find their own knowledge and develop their thinking ability. Furthermore, Nickson (Made, 2009) suggests that in mathematics instruction, the task of the teacher is to help students build mathematical concepts on their own through a process of internalization, so the concept can be built by transforming information with previous knowledge to form a new concept.

The MEAs (Model-Eliciting Activities) learning approach has the potential to develop mathematical talent, because it engage students in the complex mathematical tasks similar to the tasks applied in complete mathematics. MEAs is an *alternative* approach that seeks to make students actively involved in the learning process of mathematics in class. It is expected that students' involvement can attract their interest and develop their ability in solving mathematical problems. This is manifested in one of the characteristics of MEAs approach that gives students the opportunity to take control of their own learning with the guidance of process (Chamberlain, 2005).

Students' active involvement in the learning process will encourage them to rely on themselves in solving the problems and at the same time it will increase their reasoning abilities, searching existing connections in an attempt to solve the problem, as well as representing incident faces. This is consistent with Chamberlin (2005) stating that MEAs are also considered as the tool for revealing thought. MEAs approach is an approach to learning that emphasizes the ability to connect mathematical ideas and real phenomena. This approach is a bridge between the medel and interpretation, and provide a great opportunity to exploit knowledge to students in learning mathematics.

Based on the description of background above, the formulation of the problem in this paper are as follows:

1. Is the students' mathematical problem solving ability, whose learning uses MEAs learning better than the conventional way?
2. Is the students' mathematical connection ability, whose the learning uses MEAs learning better than the conventional way?

3. Is there an association between the ability to connect mathematical problem solving?

STUDY OF LITERATURE

a. Mathematical Problem Solving

According to Ruseffendi (2006), the problem is an issue that has never been experienced by a person and he or she has the ability to get it done, regardless of whether or not he can do it correctly. Furthermore, Ismaimuza (2010) states that "the more specific mathematical problem is a problem that is acceptable to be analyzed and may be solved by the mathematical methods". According to Minarni (2012), mathematical problem solving capabilities include the following aspects: (a) creating a mathematical model of a situation or everyday problems, (b) selecting and applying appropriate strategies, (c) explaining and interpreting the solution in accordance with the original problem. Mathematics, as a means of problem solving, aims at enabling students learn to use broad strategies in understanding the content of mathematics, recognizing and formulating problems from within and outside mathematics, using mathematical models and appropriate technology to solve deep and varied problems, including issues of real world, generalizing complishments and strategies and then applying it to the new issues, improving self-confidence to use mathematics meaningfully which in turn becomes an independent solution. Based on the above literature, the researchers concluded that the mathematical problem-solving ability is the students' ability to apply strategies to solve a variety of similar or new problems, to explain the results obtained in accordance with the initial problem and the solution for it.

b. Koneksi Matematika (Mathematical Connection)

Koneksi (*Connections*) is derived from the word *connection* in the English that means a relationship; an association between daily life and the subject matter to be studied by students and it will add students' comprehension in learning mathematics. According to the NCTM (governor, 2012), indicators of mathematical connection ability include: (a) recognizing and using the interrelationships of mathematical ideas; (B) understanding how ideas in mathematics are interconnected with one another to produce a coherent wholeness; (C) identifying and applying mathematics in contexts beyond mathematics. Furthermore, Sumarmo (2003) states that indicators of mathematical connections ability are as follows: (a) recognizing equivalent representations of the same concept; (B) recognizing mathematical procedure connection of a representation to an equivalent representation procedure; (C) using and assessing the connection among mathematical topics and beyond; and (d) using mathematics in everyday life. Based on the above literature, the researchers concluded that the mathematical connection capability is the students' ability to associate mathematical concepts with mathematics (among topics in mathematics).

c. MEAs Learning

Chamberlin (2002) developed MEAs (model-eliciting activities) with two purposes: First, MEAs would encourage students to create mathematical models to solve complex problems, such as applied mathematics in the real world; Second, MEAs are designed to enable researchers to investigate students' mathematical thinking. MEAs is a learning approach to understand, explain and communicate the concepts contained in an issue through the stages of the process of mathematical modeling. The students' mathematical model is the result of recursive process when they express an idea, test, review and extend their interpretation. In MEAs, the activities are started by presenting a problem situation that leads to the activity of generating a mathematical model used to solve mathematical problems. Students also go

through a modelling process that is expected to construct a mathematical model that is *sharable* and *reusable*.

In MEAs, the students learn actively in building knowledge (understanding) through a process of assimilation (absorping new information into mind) and accommodation; these characteristics adopt the view of constructivism (Piaget, in Istianah, 2011). The characteristics of MEAs also embraces the view Vygotsky (Istianah, 2011), that is, the interaction (communication) with its environment, the stages of providing direction, encouragement, and help them think during congestion. When discussions are on the block, Vygotsky set the process of *Scaffolding*, which is teachers' assistances in the form of questions to help or direct students to get the expected answers. To support students' interaction with the environment or with theirselves, then, the new knowledge presented should be related to the their basic knowledge that leads to meaningful comprehension in their mind. For the next process, it is more concerned with the students' activity, so that the learning will not be teacher-centered; but in this situation, the students actively learn, explore their knowledge independently.

Lesh (Cynthia and Leavitt, 2007) suggests six principles for designing MEAs, namely: (1) Model construction principle: problems must be designed to allow the creation of a model relating to the elements, relationships and operations between patterns and rules that govern the elements of that relationship, (2) the principle of reality: the problem must be meaningful and relevant to the students, (3) the principle of self-assessment: the student must be able to assess themeselves or measure the usefulness of their solutions, (4) the principle of documentation: students should be able to express and document their thinking processes in their solutions, (5) the principle of Shareability and Reusability: solutions created by students should be generalized or easily adapted to other situations, and (6) the principle of effectivity: other people should easily be able to interpret the solution. On the other hands, the stages in MEAs are identifying and simplifying problems situation, building mathematical models, transforming, completing, and identifying the models.

In the first stage, the students in discussions identify problems to solve real-world-situations-based problems and state them in the form as accurately as possible. In the second stage, students create mathematical representations by constructing a mathematical model by means of defining variables, making notations, and explicitly identifying several forms of mathematical structural relationship, making graphics or writing equations. In the third stage, *transformation*, the students analyze and manipulate the models to find mathematical solutions significant to the identified problems. In the interpretation phase, a mathematical solutions achieved from the mathematical models are re-applied to the specific or formulated problem situation. The models constructed have passed the test given in the validation process; the model is considered as a powerful model and have *sharable* and *reusable* characteristics (Lesh, in Cynthia and Leavitt, 2007) .

d. Relevant Studies

Several studies on mathematical power, among others, Zulkarnain (2009) reported that students' mathematical problem solving and communicating ability which has an open-ended approach and cooperative learning of *coop-coop* type are better than the students taught in conventional setting. Based on the aspect of learning achievement, Gordah (2009) reported that the ability of connecting and solving mathematical problems possessed by students who are taught in open-ended approach are better than the students taught in conventional setting.

The other related studies on learning MEAs among others, Widyastuti (2010) reported that the ability of the mathematical representation of students, who acquire learning Model-Eliciting Activities (MEAs) are better than students who receive conventional learning. Istianah (2011) also reported that the increasing mathematical ability to think critically and creatively of high school students who get MEAs learning is better than those who get conventional setting.

In addition, Martadiputra and Suryadi (2012) reported findings on the presence of an increase in the average difference between the disposition of statistical learning students MEAs were modified with conventional learning. This modified MEAs significantly affect the disposition statistical improvement.

RESEARCH METHOD

This study was designed in the form of experiments with posttest and control group design aimed at examining the role of MEAs in improving high school students' ability in problem-solving and mathematical connections. In addition, this research is also expected to enhance high school students' ability in problem-solving and mathematical connections. The population in this study were all high school students of class XI Cimahi, while the sample is class XI students from two high schools who were purposively set in high school in Cimahi and were randomly selected from existing class XI. Then from these samples, it was randomly assigned into which class is experimental or control. Test of students' problem solving and mathematical connections skills was arranged based on the characteristics of problem-solving and mathematical connections ability as well as the guidelines for arranging a good test. Data will be analyzed using statistical t test, and χ 2 statistical test (for testing association among variables).

RESULT AND DISCUSSION

1. Problem Solving and Mathemactical Connection

Here are the findings regarding the ability of problem solving and mathematical connections the students have as presented in Table 1.

Table 1
Students' Problem Solving and Mathematical Connection Ability

SKILLS	Initial Mathematics Ability	MEAs Class (n = 30)		Conventional Class (n = 35)	
		Mean	Deviation Standard	Mean	Deviation Standard
Problem Solving	Good	70.33	5.35	63.07	6.98
	Fair	58.18	7.81	53.79	10.14
	Less	53.50	4.98	49.50	5.27
	Total	**64.83**	**8.69**	**55.79**	**10.36**
Mathematical Connection	Good	77.28	5.70	76.79	5.17
	Fair	69.08	7.90	62.82	9.15
	Less	57.24	5.48	54.78	6.23
	Total	**70.87**	**9.48**	**65.81**	**9.97**

After the normality test of disseminated data of students' problem solving and mathematical connection, then it was determined that the data have normal distribution. Based on the finding, then, the test of standard deviation of the two abilities was completed by using test of two SD differences (presented in Table 2).

Table 2
The Recapitulation of test of two SD differences using t-test

between MEAs and conventional learning

Skills	Sig.	Interpretation
Mathematical Problem Solving	0.000	On 5% of significance level, the mathematical problem solving skills possesed by the students who use MEAs learning are better than those who taught in conventional learning
Mathematical Connection	0.020	On 5% of significance level, the mathematical connection skills possessed by students who use MEAs learning are better than those who taught in conventional learning

Source : adopted from output of SPSS 19

Based on the results of data analysis above, the interpretation obtained are as follows:

a) The mathematical problem solving skills possesed by the students who use MEAs learning are better than those who taught in conventional learning. In MEAs and conventional settings, it is categorized as *Normal* (MEAs = 64.83 from ideal score 100, and KONV = 55.79 from ideal score 100).
b) The mathematical connection skills possessed by students who use MEAs learning are better than those who taught in conventional learning. k In MEAs and conventional settings, it is categorized as *Good* (70.87 from ideal score 100). While, in the conventional setting, it is categorized as *Enough* (65.81 from ideal score.

2. The Association of Problem Solving and Mathematical Connection Skills

The existence of associations among students' mathematical abilities was analyzed using contingency tables between two variables as presented in Table 3 and Table 4 .

Table 3
The Association of Problem Solving and Mathematical Connection Skills

MATHEMATICAL SKILLS	Contingency Coeficient	Sig.	INTERPRETATION
Problem Solving and Mathematical Connection	0.533	0.018	There is a significant association on 5% of significance level

Source: adopted from output of SPSS 19

The analysis results of Table 3 showed a strong association between problem solving and mathematical connection skills possessed by the students. In addition, based on the Table 4, it can be concluded that the questions on problem solving skills are more difficult than that on mathematical connection. It can be seen on the fact that there is a lot of students with high categories (problem solving = 10, mathematical connection = 17), and there is also a lot of students with low categories (problem solving = 7, mathematical conection = 4).

Table 4 The Contingency of Problem Solving and Mathematical Connection

Problem Solving	Connection			Total
	Low	Fair	High	
Low	3	2	2	7
Fair	1	6	6	13
High	0	1	9	10
Total	4	9	17	30

The findings of the association among skills in this study are similar to the findings of the previous study in that there is an association between high school students' ability of

mathematical critical and creative thinking (Hidayat, 2011), an association between their creative ability and mathematical disposition (Wardani, 2009), between their communication skills and independent learning (Qohar, 2009), and between a high level of mathematical ability possessed by high school students and their learning independence (Sugandi, 2010). The above findings indicate that the association among students' mathematical skills in learning mathematics is quite consistent.

CONCLUSION AND SUGGESTION

Based on the data analysis and discussion above , the conclusions in this paper are as follows:

1. The mathematical problem-solving abilities possessed by the students whose learning uses MEAs are better than those who taught in conventional setting. The ability of both classes belong to the category of *Fair*.
2. The mathematical connection abilities possessed by the students whose learning uses MEAs are better than those who taught in conventional setting. MEAs students' ability belongs to the category of *Good*, while the conventional students' ability belongs to the category of *Fair*.
3. There is an association between the ability of solving mathematical connection problems and the category of Strong Enough.

REFERENCES

Chamberlin, S. A. (2002). Analysis of interest during and after Model-eliciting Activities: A comparison of gifted and general population students. Unpublished doctoral dissertation.

Chamberlin, S. A., Moon, S. M. (2005). How Does the Problem Based Learning Approach Compare to the Model-Eliciting Activity Approach in Mathematics?. (http://www.cimt.plymouth.ac.uk/journal/chamberlin.pdf)

Cynthia, A., dan Leavitt, D. (2007). Implementation strategies for Model Eliciting Activities: A Teachers Guide. [Online]. http://site.educ.indiana. edu/Portals/ 161/Public/ Ahn%20 &%20 Leavitt.pdf. [12 Maret 2013]

Depdiknas. (2006). Panduan Pengembangan Silabus Mata Pelajaran Matematika untuk SMP. Jakarta: Ditjen Dikdasmen

Elia, I. (2007). Multiple representations in mathematical problem solving: Exploring sex differences. [Online]. Available: http://www. prema.iacm. forth.grdocs/ws1/papers/Iliada%20Elia.pdf. [10 November 2007]

Gordah, E.K. (2009). Meningkatkan Kemampuan Koneksi dan Pemecahan Masalah Matematika Melalui Pendekatan *Open Ended*. Tesis UPI: Unpublished.

Hidayat, W. (2011). Meningkatkan Kemampuan Berpikir Kritis dan Kreatif Matematik Siswa SMA Melalui Pembelajaran Kooperatif *Think-Talk-Write*. Tesis UPI: Unpublished.

Hwang, *et al*. (2007). Multiple Representation Skills and Creativity Effects on Mathematical Problem Solving using a Multimedia Whiteboard System. Educational Technology & Society, Vol 10, No 2, pp. 191-212.

Irwandi. (2012). Daya Matematis. [Online]. http://irwandiaini.blogspot.com/2012/09/daya-matematis.html. [20 April 2013]

Ismaimuza. (2010). Kemampuan Berpikir Kritis dan Kreatif Matematis Siswa SMP Melalui Pembelajaran Berbasis Masalah Dengan Strategi Konflik Kognitif. Disertasi UPI:

Unpublished.

Istianah, E. (2011). Meningkatkan Kemampuan Berpikir Kritis dan Kreatif Matematik dengan Pendekatan MEAS (*Model-Eliciting Activities*) Pada Siswa SMA. Tesis UPI: Unpublished.

Made, W. (2009). Strategi Pembelajaran Inovatif Kontemporer Suatu Tinjauan Konseptual Operasional. Jakarta: Bumi Aksara

Martadiputra, B. A dan Suryadi, D. (2012). Peningkatan Kemampuan Berpikir Statistis Mahasiswa S1 Melalui Pembelajaran MEAs yang Dimodifikasi. Jurnal Infinity, Vol 1, No 1, pp. 79-89.

Minarni, A. (2012). Pengaruh Pembelajaran Berbasis Masalah Terhadap Kemampuan Pemecahan Masalah Matematis. Seminar Nasional Matematika dan Pendidikan Matematika FMIPA UNY 10 November 2012. mp-94

Qohar, A. (2009). *Mengembangkan Kemampuan Komunikasi Matematis dan Kemandirian Belajar Siswa SMP melalui Reciprocal Teaching*. Disertasi UPI: tidak diterbitkan.

Ruseffendi, H. E. T. (2006). Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika Untuk Meningkatkan CBSA. Bandung: Tarsito.

Sanjaya. W. (2006). Strategi Pembelajaran Berorientasi Standar Proses Pendidikan. Jakarta: Kencana Prenada Media Group

Sugandi, A. I. (2010). *Mengembangkan Kemampuan Berfikir Tingkat Tinggi Siswa SMA melalui Pembelajaran Berbasis Masalah dengan Setting Belajar Koopertaif JIGSAW*. Disertasi UPI: Unpublished.

Sumarmo, U. (2003). Daya dan Disposisi Matematik: Apa, Mengapa dan Bagaimana Dikembangkan pada Siswa Sekolah Dasar dan Menengah. Makalah disajikan pada Seminar Sehari di Jurusan Matematika ITB, Oktober 2003. [Online]. http://educare.efkipunla.net/index.php?option=com_content&task=view&id=62 Jurnal pendidikan dan budaya. **[**4 Januari 2011**]**.

Sumarmo, U. (2005). Pembelajaran matematika untuk mendukung pelaksanaan kurikulum tahun 2002 sekolah menengah. Makalah Disajikan pada Seminar Pendidikan Matematika di FPMIPA Universitas Negeri Gorontalo: Unpublished.

Wardani, S. (2009) *Meningkatkan kemampuan berfikir kreatif dan disposisi matematik siswa SMA melalui pembelajaran dengan pendekatan model Sylver*. Disertasi UPI: Unpublished.

Widyastuti. (2010). Pengaruh Pembelajaran *Model-Eliciting Activities* terhadap Kemampuan Representasi Matematis dan *Self-Efficacy* Siswa. Tesis UPI: Unpublished.

Yuan, S. (2013). Incorporating Pólya's Problem Solving Method in Remedial Math," *Journal of Humanistic Mathematics*: Vol. 3: Iss. 1, Article 8. Hal 98. Available: http://scholarship.claremont.edu/jhm/vol3/iss1/8

Zulkarnaen, R. (2009). Meningkatkan Kemampuan Pemecahan Masalah dan Komunikasi Matematik Siswa SMA Melalui Pendekatan *Open-ended* dengan Pembelajaran Kooperatif Tipe *Coop-coop*. Tesis UPI: Unpublished