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DEVELOPING FUTURE TEACHERS' EDUCATIONAL MODEL

Medan, November 19th, 2016
Auditorium Building - UNIMED

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"Developing Future Teachers' Educational Model"

State University of Medan, North Sumatera, Indonesia
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Chairman Foreword

The honorable,

- *Professor Peter Charles Taylor, PhD, Director of Transformative Education Research Centre and a Professor of STEAM Education at Murdoch University, Perth - Western Australia*
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- *Director of Postgraduate School of UNIMED*
- *Lecturers, researchers, students, all speakers and participants*

Assalamualaikum Wr Wb

Good Morning, *Salam Sejahtera,* Praise to Allah the Almighty for all His blessing, where today we are here to participate in 'The First Annual International Seminar on Transformative Education and Educational Leadership' with the theme "Developing Future Teachers' Education Model".

Ladies and Gentlemen,
This seminar presents a keynote speaker, 5 guest speakers from Australia, Malaysia and Indonesia and 132 researchers covering lecturers, teachers and students with around 860 participants. The researchers come from Manado, Palu, Kendari, Malang, Surabaya, Solo, Bandung, Jakarta, Palembang, Jambi, Batam, Pekanbaru, Padang, Aceh, Medan and North Sumatera.

I would like to express greatest thankful to all colleagues in the steering committee for cooperation in administering and arranging the seminar. Hopefully this seminar will be continued in the coming years with many more insight articles from inspiring research.

Wassalamualaikum Wr. Wb.

Rahmad Husein

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Welcoming Speech of Director of Postgraduate Study State University of Medan

Best wishes for all of us,

First of all thanks to God who has given grace and health to us so that we can assemble this place to attend The First Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL) 2016. This seminar is organized by Postgraduate Study (PPs) of the State University of Medan (Unimed). Welcome to all keynote speakers, researchers, students and, participants.

This international seminar is one of the manifestations of the vision and mission of PPs of Unimed, namely the dissemination and implementation of the results of research and studies related to the community. Therefore we strongly support the activities of this seminar which is also a series of academic activities of Unimed. Through this seminar, the participants will exchange information related to the latest research in the field of Transformative Education and Educational Leadership, which is expected to bring new ideas in solving various problems that arise particularly in the world of education.

In accordance with the theme presented in this seminar "Developing Future Teachers Education Model" it is expected that PPs Unimed can lead and strengthen the future teachers. The goal of transformative education is to develop visionary teachers and teacher educators to be capable of and committed to transforming education systems worldwide so that they prepare citizens with high-level abilities for solving global crises such as internationally political conflicts, climate change and loss of biocultural diversity.

Thank you for all committee to has well organized this seminar. Thanks to all keynote speakers who have attended, presented and shared their ideas on transformative education and educational leadership. Thanks to all researchers, students and participants and hopefully this will be scientific discussion to develop the future education.

Finally, I hope that all academicians and stakeholders of PPs Unimed hand-in-hand to excel our institution to be a world class university.

Best wishes for all of us

Director,

Prof. Dr. Bornok Sinaga, M.Pd

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THE EFFECT OF LEARNING MATERIALS BASED ON JOYFUL PROBLEM BASED LEARNING TOWARDS STUDENTS MATHEMATICAL UNDERSTANDING ABILITY

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Abstract - The implementation of learning materials developed based on Joyful Problem Based Learning (JPBL) has been carried out from March to July 2016. The subject of the research is 8 grade students at Public Junior High School (PJHS) 27 Medan, PJHS 1 Percut, and PJHS 7 Pematangsiantar. The data was collected by 5 essay test given at the beginning and at the end of all learning process. Then data was analyzed using t-test Independent. The results showed there was the improvement of the students' mathematical understanding ability (MUA) at all school included in this research. Some aspects of MUA in this study include the ability to connect and represent problem in various ways. The achievement of students in these two aspects are quite balanced with a mediocre category. It is recommended to teachers to use this learning materials which is developed based on JPBL in order to get the students ability in MUA.

Keywords: Mathematical understanding, Joyful Learning, Problem-based Learning.

1. INTRODUCTION

In the post-industrial era, the demands on the quality of human resources increasingly complex, it being understood that the present era is the era of information and communication technology in which rapid development of information and communication technologies require capable humans in order to get benefit and prosper. One sector that plays an important role in developing human resources is education. Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs, and habits.

The process of learning through education can be facilitated through mathematics because mathematics is a universal science that underlies the development of modern technology, have an important role in a variety of disciplines and advance the capabilities of human thinking (logical, analytical, systematic, critical and creative) (MoE, 2006). In fact, when someone is in the process of acquiring the content of mathematics through problem solving, then that person is constantly thinking analytical, systematic, critical, logical and creative.

The ability to think can be achieved by students if mathematics is given through Problem-based Learning (PBL). Through PBL students are trained to look for solving the problem. Actually, problem solving is used as a means to build new mathematical knowledge, typically by building on students' prior understandings. The key word here is the problem. Mathematical problems play role to force students individually or in groups to attain the solution. That problem is designed so that it can generate high order thinking skills (HOTS) as proposed by Resnick (Arends, 2004), that is, tends to be complex, often yields multiple solutions, involves uncertainty, involves self-regulation of the thinking process, impossing meaning, finding structure in apparent disorder, and effortful.

Students will be able to solve mathematical problems if he is able to understand his problems, and understand what must be solved from the problem. Thus, the key mathematical problem-solving ability is the ability in mathematical comprehension (understanding abilities) (Indonesia MoE, 2006). In the NCTM (2000) also noted that the students' skills in understanding allows students be able to solve the problem. Explicitly mentioned in Indonesian MoE (2006) that the ability of mathematical understanding is the main purpose of learning math at school. Unfortunately, until now the students have not achieved yet that ability, especially the students either at junior or high school. Their abilities in mathematical understanding are still low (TIMSS 2011; PISA 2012; Minarni, 2013).

Marzano & Kendall (2007) stated that the ability of understanding is an ability to integrate information and make a symbol for such knowledge. Integrating is the process of combining new information received to the information already available in the cognitive structure of the students. Example of integrating process is the process of applying knowledge of Pythagorean rule to form algebraic equations. Symbolization process is to determine the equation of a problem. On the other

hand, with referred to Hiebert & Carpenter (1992), a process of understanding involves mathematical connection ability and representation. Carpenter & Lehrer (1999) suggest that understanding is the process of bringing together small pieces of information that were scattered. Thus, it can be summarized that if wanted to assess the ability of mathematical understanding of students, teachers can assess how students represent (external representation) what is contained in the structure of cognitive (internal representation) related to the problems faced, then how these students make connections among various representations made.

As well as problem solving ability, the ability of mathematical understanding can be developed in the classroom through Problem-based Learning (PBL). Problems intended to elicit mathematical understanding can be designed by considering the aspects of the mathematical connection and representation. That is, the problem of mathematical understanding should be issued a student's ability to represent and connect.

2. THEORETICAL BACKGROUND

2.1. Mathematical Understanding

According to Marzano & Kendall (2007: 21), understanding is one part of the cognitive system, while the relationship between cognitive systems and knowledge can be seen in Figure 1.

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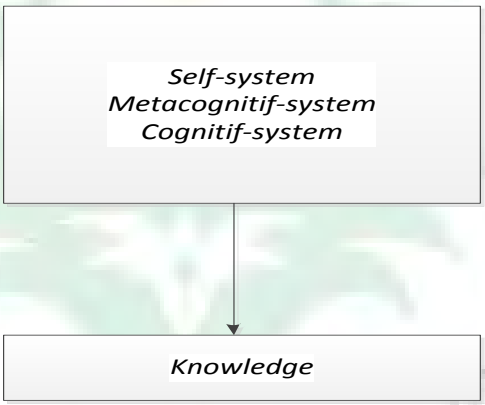

Figure 1. Knowledge Domain

Knowledge is the key to a person's ability to engage and manage a new task. By having the necessary knowledge, the child will have a high motivation to engage in tasks (think self-system). Domain knowledge is interrelated and became the object of the action of cognitive, metacognitive, and a system of self (self-system). Domain knowledge consists of: (1) the information domain (declarative knowledge): a glossary of terms, facts, generalizations, principles), (2) mental procedures (knowledge procedural) covering macro-procedure, skills (tactics, algorithms and single rule). (3) The procedure Psychomotor domain, built by physical procedures used by someone to negotiate everyday life and to engage in physical activity at work and recreation.

The process of understanding includes storing critical features of information in permanent memory. There are two things that were involved in the process of understanding: (1) integrating and (2) symbolizing. Integrating is a knowledge screening process into the key characteristics, organized as economical as possible and in a general form, technically called macro-structure. The integration process includes mixing the knowledge that had just experienced with the available knowledge stored in the permanent memory of the student. Symbolization is to understand the process by creating a symbolic analogy of the knowledge that is in the macro-structure; knowledge is processed into two main modes: linguistic and mental images. So the symbolism is the shift of knowledge contained in the macro-structure in the form of symbolic (non-verbal). For example: 'In a triangle ABC, right-angled at A, the Pythagorean formula is written symbolically as $a^2 + b^2 = c^2$.

Symbolization process assumes the integration of knowledge accurately. Therefore, in order to create a symbol of knowledge, students need to make their knowledge connected tightly and firmly.

Anderson, *et al.* (2001: 70-75) stated that a person is called to understand if he can construct meaning from instructional messages that include oral communication, text, and graphics in any form as presented in the classroom, book, or a computer screen. Students understand when they establish a relationship between the knowledge to be obtained (new knowledge/incoming knowledge)

with their prior knowledge. Cognitive processes of understanding covering interpret, give examples, classifying, summarizing, inferring, comparing, and explaining.

The framework to understand understanding is based on the representation and connections (Hiebert and Carpenter, 1992). This idea could become a reference to the question of how children learn with understanding and how to teach for understanding. Attempts to understand how people learn and understand mathematics is largely based on the assumption that knowledge is represented internally, and the internal representation is structured (Hiebert & Carpenter, 1992: 66). According to the authors, to think and express mathematical ideas, we need the capability to disclose it in various ways (external representation in the form of spoken language, written symbols, or physical objects).

According to Inhelder & Piaget (Slavin, 2008), "Developing understanding Involved increasing ability to hold several relationships in mind, permitting further abstraction and anticipation". Hiebert & Carpenter (1992: 69) stated that the network or mental representations awoke slowly when new information is connected to an existing network or a new relationship formed between the information that had been separated from each other. In line with the growing understanding of the network whenever they are increasingly large and increasingly organized. However, an understanding can be limited if only a partial representation of the idea of the actual mental potentially interrelated, interconnected, or if the relationship is weak. Understanding is increased when the network grows and existing relationships strengthened through the experience and the network structure is more tightly bound.

Activities that may elicits mathematical understanding includes building relationships between mathematical topics or between mathematics with other sciences, extend and apply mathematical knowledge in solving problem, let the students give articulation to the new-found knowledge, and make the students as the owner knowledge they found.

2.2. Joyful Problem Based Learning

Direct teaching could make the students grasp abundant of knowledge but it could not promote students' problem solving ability and even understanding ability and transfer knowledge to new situation (Ronis 2008). On the other side, there is learning model, that is Problem Based Learning (PBL), which can be hoped to increase transferring knowledge to new problems, integrating concepts, catering intrinsic learning motivation and skills (Wilson, 1997). PBL start the learning process by giving problems to the students, and have some other caracteristics such as the problems should be designed as ill-structured problems, trigger learning, student-centered, while teacher takes role as tutor, coach, or facilitator, students worked in groups to analyze, investigate, discuss, and propose solution, also improving and encouraging self and group-assessment.

Problems proposed in PBL classroom should be designed properly to give context and meaningful, considering scope, conected to student's need and students' previous knowledge to motivate and engage students in solving problem (Tan, 2003). Assestment in PBL classroom is made along the learning process run, not only based on paper and pencil test only. It is and is called as a holisctic assestment. The teacher cans help the students by proposed question and probes as a scaffold for the students to solve the problems. But scaffolding must be eliminated gradually so in the end the students become a self-learner and good problem solver. The weaknesses and success story of implementing PBL can be seen in Tan (2003; Ronis, 2008; Napitupulu, 2011).

Meanwhile, Joyful Problem-Based Learning means problem-based learning that is designed such that the learning activity is conducted in pleasant environment and convenient situation. Sometimes learning is conducted outside the classroom and using a variety of hands-on manipulatives around the classroom or school yard that is interesting for students; the teacher scaffolds the students with friendly language (tone of the teachers' voice, facial expression, body posture and gesture makes the child comfortable). The objects that exist inside and outside the classroom, as well as the environment around the classroom can be used as devices to increase the interest of students to learn, but the focus remains on efforts to lead the students making a variety of representations for a problem and making connection between facts, mathematical ideas, procedures and concepts so they understand what to be solved in the problem and attain knowledge being studied.

3. METHODS

3.1. Subject of The Research

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The subject of the research is the students in public junior high school (PJHS) in the Province of North Sumatera, Indonesia. Three PJHS are chosen randomly. There are 88 students engaged in the research, they are from PJHS 27 Medan, PJHS 1 Percut, and PJHS 7 Pematangsiantar.

3.2. *Instrumentation*

The ability of mathematical understanding in this research is the ability to represent the problems into various external representation and make connection between the problem into mathematical knowledge they have grasped along learning process. Aspects of mathematical understanding ability in the research follow aspects proposed by Anderson (2001). Five item of essays test are given to the subject of the research.

3.2. Learning Material

Learning material consist of Student Activity Sheets (SAS), Student's Book, Lesson Plan, Instrumentation, Observation & Interview Guidance. Content of material instruction consists of System of Linear Equation of Two Variables and Pythagorean Rule. According to Nieveen (2013), intervention in instruction is effective if using the intervention results in desired outcome. The desired results of this research among others the improvement of the students' MUA, the students and teachers' positive response towards developed learning materials, and the improvement of the students' engagement in the classroom discussion.

3.4. *Implementing Learning Material*

Learning materials developed based on JPBL implemented on 88 students in three schools. Learning implementation thoroughly monitored by observers to comply with the syntax of PBL and joyful learning. That is, there are times when teachers take students out of the classroom to experience the real problems associated with SPLDV.

Overall, activity in learning process take place like in the following order: At the first meeting, the teacher gives pre-test. nine meetings used to carry out learning process using the developed learning materials. At the end of implementing developed learning materials, all 88 students take a post-test of MUA (mathematical understanding ability).

Five syntax of PBL used in the research including (1) organize the students into small group discussion, (2) orient the students to the problem, motivate them to engage in solving the problem, (3) Assists students in planning and preparing appropriate reports, ppt presentation, and poster, help students share their work with others, (4) help students to reflect on the process of solving problem they used, (5) facilitate students to presenting the result of their work.

Learning materials developed in this study is said to be effective if more than 50% of students received a score of over 70 in test of mathematical understanding ability (MUA); get positive response from the students and the teachers give positive response towards learning materials, and the students engagement in solving problems improved.

4. RESULTS AND DISCUSION

Table 1 displays a description of mathematical understanding abilities (MUA) of the students in three schools after the implementation of learning materials developed by JPBL.

Table 1. Skor Rata-rata Kemampuan Pemahaman Matematis Siswa

Type of test	PJHS 27 Medan		PJHS 1 Percut		PJHS 7 P.Siantar	
	Average	SD	Average	SD	Average	SD
Pre-test	7,441	2,134	7,153	1,349	6,75	1,404
Pos-test	12,147	2,720	12,153	2,475	12,071	2,750

Note: Max score = 20

Table 1 shows the difference in average scores of MUA between pretest and posttest. This represents an increase understanding of mathematical ability of students in three schools. Through a statistical test, this data has a normal distribution properties and homogeneous variance so statistical independent t-test o test is used to analyze the difference between pretest and posttest scores (Table 2). Tests carried out at 95% confidence level. The test results turned out to be significant for the three schools involved in the study, so it can be concluded that there is an improvement of the students' MUA after the implementing JPBL in the classroom.

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Table 2. Mean difference of The Students' Mathematical Understanding Ability

School	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PJHS 27 Medan	.000	8.865	50	.000	5.000	.564
PJHS 1 Percut	.000	8.865	50	.000	5.000	.564
PJHS 7 P.Siantar	.022	6.574	54	.000	4.357	.663

Here is the distribution of the interval score of the students' MUA.

Table 3. Score Interval of Students MUA

Interval	PJHS 27 Medan	PJHS 1 Percut	PJHS 7 Siantar
12 ≤ X ≤ 15	22	16	18
9 ≤ X ≤ 11	7	3	6
X ≤ 8	5	7	4
N	34	26	28

Note: Max score = 20

From Table 3 can be seen that more than 60% of the students acquire average score of 70 or more. So, there is an improvement of mathematical understanding of the students. It means, learning materials developed based on JPBL was effective to fulfill the desired criteria, it must be more than 60% of the students achieved score 70. But, still further research needed to conduct in order to get higher classical achievement, that is more than 80% of the students get score 70 for MUA test. Hopefully, within the next study the revised learning materials can be implemented in five schools in the city of Medan, Percut Sei Tuan, Tebingtinggi, and Pematangsiantar.

The Student Performance

Figure 2 shows an example of MUA test. That problem requires the ability of the students to connect their knowledge to the concept of gradient of a line which is parallel to other line, then represent new line based on gradient information about parallel line.

Problem

Look at the figure below, lines *k* and *l* represent by y = 2x + 2 and y = 2x respectively. If line *m* is parallel to the line *k* and *l*. Determine the line equation of line *m.*

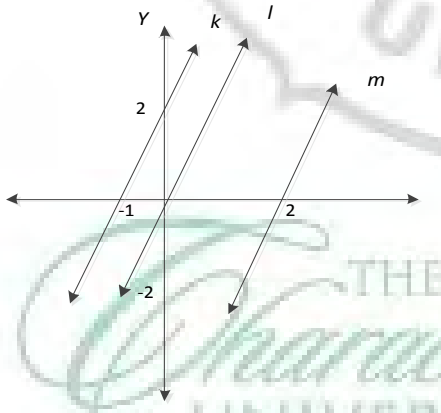

Figure 2

Figure 3 displays the student performance in pre-test of mathematical understanding ability (MUA).

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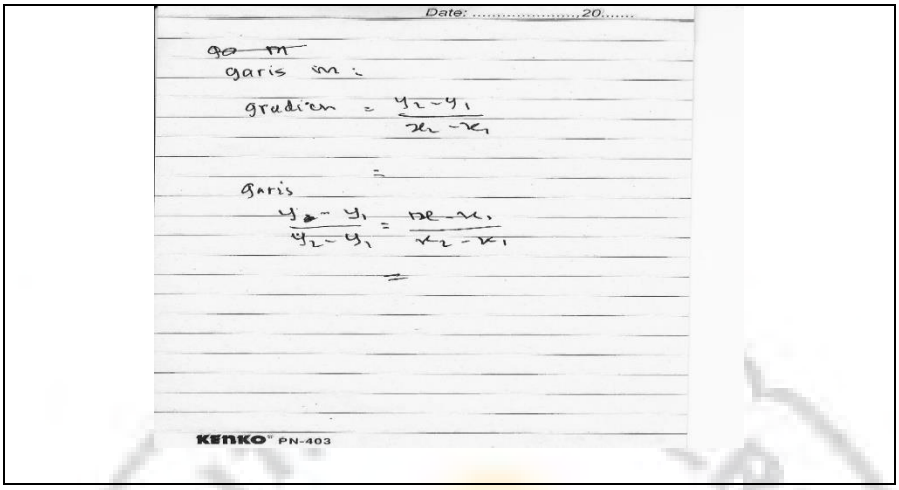

Figure 3

The performance of the student in pre-test presented in Figure 3 showed that this student could not do anything instead of writing an equation of gradient and an equation of any line. This is reasonable, as long as learning process is conventional learning which always start learning with the teacher explaining the material, followed by giving the example problems and their resolution, asking the students do the problems similar to those the described teacher (routine problems), until at the end of the lesson teachers give homework to students. Learning like this is hard to make the students understand the knowledge they learned, moreover apply that knowledge to complex problems. The finding is in line with Ronis (2008).

Figure 4 presented the student performance in post-test of mathematical understanding ability (MUA).

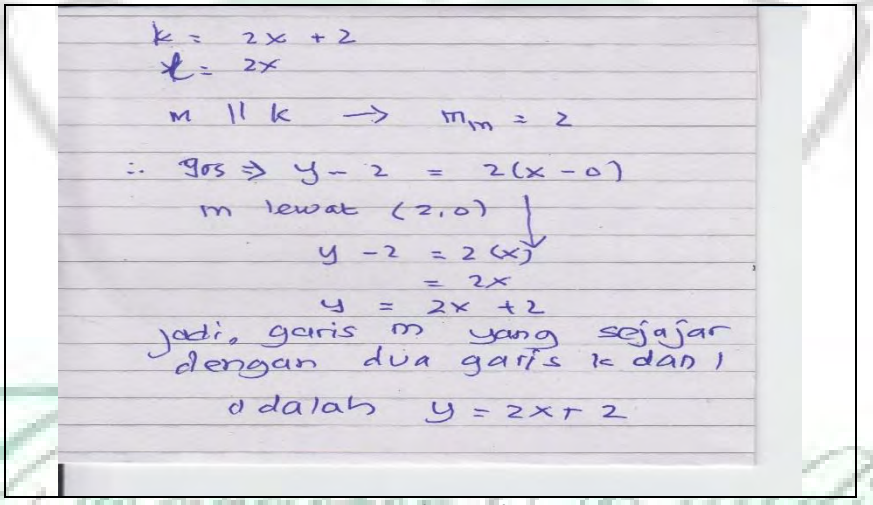

Figure 4

The performance of the student in MUA post-test presented in Figure 4 showed that this student understood the concept of parallel gradient, he also fluent in determining a point lies in line *m.* So, he did not have difficulty in solving this problem, even gave perfect solution.

Overall, after implementing learning materials developed based on JPBL, the students' performance has improved significantly (Table 1). This finding support the power of problem based learning which is conducted in joyful environment. Teachers as well as students gave positive response toward learning materials. The students' engagement in group discussion has improved. Furthermore, based on observation result, the teachers activity in learning process fulfill JPBL requirement.

The weaknesses found in this research including too much time needed to conduct learning activity. Much of the time consume by the activity to encourage the students to be consistently in solving the problem; the teachers need to do a lot of effort to make scaffolding is only given as needed, students must continue to solve the problem diligently in order to be able to build their own

knowledge (this part is rather hard to be). Assessment of students' performance also requires a lot of time because it is done holistically. Teachers actually experiencing fatigue. Time was too limited to make the students have fun learning outside the classroom.

To overcome the weaknesses in implementing learning materials developed based on JPBL no other way than the dedication of teachers consistently. By providing this dedicated, teachers can get the excitement that could not be measured with money. Why not, because actually the real teacher is the people who really want their students to master science is taught by him.

5. CONCLUSIONS

1. Learning materials developed based on JPBL is effective to improve the students' mathematical understanding ability.
2. The teachers and the students' response towards learning materials are positive.
3. The weakness of this study include lack of seriousness in working to solve problems of students, the students easily give up and frustrated (there is no perseverance they have), teachers are not skilled in providing scaffolding, therefore they still need training to master the technique of scaffolding.

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