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AND OPERATION RESEARCH (ICNOOR)
2017

NOVOTEL HOTEL, BUKITTINGGI, 27 - 29 AUGUST 2017

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INTERNATIONAL CONFERENCE ON MATHEMATICS AND MATHEMATICS EDUCATION (ICM2E 2017)

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GRADUATE PROGRAMME OF MATHEMATICS EDUCATION
MATHEMATICS AND SCIENCE FACULTY
UNIVERSITAS NEGERI PADANG
AUGUST, 27th - 29th , 2017

Message from the Rector of Universitas Negeri Padang

Ladies and Gentlemen,

It gives me great happiness to extend my sincere and warm welcome to the all participants of the International Conference on Mathematics and Mathematics Education (ICM2E 2017)

On behalf of Universitas Negeri Padang, let me welcome all of you to the conference in Bukittinggi, West Sumatra Province, Indonesia. We believe that from this scientific meeting, all participants will have time to discuss and exchange ideas, findings, creating new networking as well as strengthen the existing collaboration in the respective fields of expertise. In the century in which the information is spreading in a tremendous speed and globalization is a trend.

Universitas Negeri Padang must prepare for the hard competition that lay ahead. One way to succeed is by initiating and developing collaborative work with many partners from all over the world. Through the collaboration in this conference we can improve the quality of our researches as well as teaching and learning process in mathematics, science and technology.

I would like to express my sincere appreciation to mathematics department on mathematics and science faculty and organizing committee who have organized this event. This is a great opportunity for us to be involved in an international community. I would also like to extend my appreciation and gratitude to keynote speakers, parallel keynote and participants of this conference for their contribution to this event.

Finally, I wish all participants get a lot of benefits at the conference. I also wish all participants can enjoy the atmosphere of the city of Bukittinggi, West Sumatra.

Thank you very much

Prof. Ganefri, Ph.D
Rector

Message from Dean of Faculty of Mathematics and Sciences Universitas Negeri Padang

Rector of Universitas Negeri Padang
Vice-Dean of the Faculty of Mathematics and Sciences
Head of Graduate Program in Faculty of Mathematics and Sciences
Head of Department in Faculty of Mathematics and Sciences
Distinguished Keynote Speakers
Organizers of this conference
Dear participants
Ladies and gentlemen

I am delighted and honored to have this opportunity to welcome you to International Conference on Mathematics and Mathematics Education (ICM2E 2017), which is hosted by Mathematics Department, Faculty of Mathematics and Science, Universitas Negeri Padang.
As the Dean of Faculty of Mathematics and Science, I wish to extend a warm welcome to colleagues from the various countries and provinces. We are especially honored this year by the presence of the eminent speaker, who has graciously accepted our invitation to be here as the Keynote Speaker. To all speakers and participants, I am greatly honored and pleased to welcome you to Padang. We are indeed honored to have you here with us.

The ICM2E 2017 organization committee has done a great work preparing this international conference and I would like to thank them for their energy, competence and professionalism during the organization process. For sure, the success I anticipate to this conference will certainly be the result of the effective collaboration between all those committees involved.
This conference is certainly a special occasion for those who work in education, mathematics, science, technology, and other related fields. It will be an occasion to meet, to listen, to discuss, to share information and to plan for the future. Indeed, a conference is an opportunity to provide an international platform for researchers, academicians as well as industrial professionals from all over the world to present their research results. This conference also provides opportunities for the delegates to exchange new ideas and application experiences, to establish research relations and to find partners for future collaboration. Hopefully, this conference will contribute for Human and Natural Resources.

I would like to take this opportunity to express my gratitude to all delegates for their contribution to the ICM2E 2017.
Thank you,

Dean of The Faculty of Mathematics and Sciences
Prof. Dr. Lufri, M.S.

Message from the Chairman of Organizing Committee

First, I would like to say welcome to Bukittinggi Indonesia. It is an honor for us to host this conference. We are very happy and proud because the participants of this conference come from many countries and many provinces in Indonesia.

Ladies and gentlemen, this conference facilitates researchers to present ideas and latest research findings that allows for discussion among fellow researchers. Events like this are very important for open collaborative research and create a wider network in conducting research.

For all of us here, I would like to convey my sincere appreciation and gratitude for your participation in this conference.

Thank you very much

Dr. Irwan, M.Si
Chairman

THE COMITTEE OF INTERNATIONAL CONFERENCE ON MATHEMATICS AND MATHEMATICS EDUCATION (ICM2E 2017)
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TABLE OF CONTENTS

ISBN : 978-602-50919-0-2
International Conference on Mathematics and Mathematics Education (ICM2E 2017)
Universitas Negeri Padang, West Sumatera Indonesia
Novotel Hotel, August 27th – 29th 2017

ANALYSIS OF STUDENT DIFFICULTIES IN SOLVING PROBLEMS OF ANALYTICAL GEOMETRYIN PARABOLIC AND HIPERBOLIC MATERIALS

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Abstract

This research aims to identify students' difficulties in solving analytic geometry problems on parabolic and hyperbolic materials. The analytical geometry is one of the main subjects. The subject of this research is the second semester student of Mathematics Department at Universitas Negeri Padang. Type in this research is descriptive research. type in this research is qualitative approach. The data collection techniques in this research is by the method of documentation, tests and interviews. Data analysis is done by comparing data of analytic geometry test result and interview result. From the result of the research, it can be concluded that students' difficulties in solving the analytical geometry problem of parabolic and hyperbola matter are difficulty in memorizing the formula used to do the given problem. Difficulty in determining the steps of the given problem and difficulty in understanding the purpose of the given question.

Index Terms— *Analitic of difficulties, parabolic, hyperbola*

INTRODUCTION

Education that is able to support future development is education that has the ability to develop the potential of learners, so that they can face and solve the problem of life. The government has conducted improvements to improve the quality of education in various types and levels, including improvements in the curriculum in universities, striving to improve the ability of mathematics, especially in analytical geometry courses taught in the mathematics department at the Universitas Negeri Padang.

Analytic geometry is a continuation course of geometry that studies the plane and space, as stated Muhassanah (Yuwono, 2016: 2). This course aims to develop the ability of students in understanding the concept and applying it into the form of exercise questions. The analytical geometry of the field is one of the compulsory subjects that must be taken by Mathematics students. On the curriculum structure, the courses are in the second semester. Especially the course content: (1) Parabola, and (2) Hiperbola,

In general, the material has been previously studied in high school. Based on interviews conducted by researchers with lecturers of analytic geometry courses obtained in the Academic Year 2016/2017 the number of students who graduated in the field of analytical geometry field that is less than 70% of the 44 people the number of students who take courses Analytical Geometry.

Students are still having difficulty in applying the concept especially parabolic and hyperbola material. Furthermore, the results of interviews conducted with some students obtained information that they are still difficult in applying the concept, especially for parabolic and hyperbolic matter. Students are also not used to describe parabolic and hyperbolic equations on plane if given different equations.

Based on the pre-liminary observations by researchers, factors causing the number of students who score below the average are: ability to remember, ability to understand concepts, and learning difficulties.

Referring to the results of research Muhassanah (Yuwono, 2015: 113) argues that the difficulties of students in solving the problem of analytic geometry is memorizing the formula used to do the given problem, the difficulty in determining the steps of solving the problem given and difficulties in understanding the purpose of the given question.

Based on those problem, the researcher is interested to conduct research on the analysis of the types of student difficulties in solving analytic geometry as well as the analysis of factors causing students to have difficulty in completing analytic geometry on parabolic and hyperbola materials

LITERATURE REVIEW

a. Analytical Geometry

In this course students will learn about Cartesian Coordinate, Conical Sliced, Equation tangent and normal line, coordinate coordination and rotary field space. Students will learn to understand and can explain the material of analytic geometry of both plane geometry and space geometry.

b. Parabola

Parabola is the place where the dots are located to a certain point equal to the distance to a particular line (direktriks).

c. Hyperbole

Hyperbole is the place of the points that the difference of point distance to two particular points has a fixed value. These two specific points are called the focus of hyperbole.

RESEARCH METHOD

This approach uses descriptive qualitative research. This research was conducted on the students of Mathematics Study Program semester two academic year 2016/2017 Faculty of Education and Natural Sciences at Universitas Negeri Padang.

Techniques used in data collection in this study is Documentation includes the results of student tests on Final Exam Semester Even academic year 2016/2017 in the course of Analytical Geometry and Interviews in this study using semi-structured interview. Where in determining the subject of the interview is taking some two semester students who get poor results on the final exam in the course of Analytical Geometry and students who have high ability.

Students who take the course of Analytical Geometry in the majors of mathematics amounted to 44 people. Students are divided into two groups namely high and low groups. The researchers took the test results of each group at random to analyze the form of difficulty. Data analysis technique used in this research is qualitative, that is descriptive method.

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Universitas Negeri Padang, West Sumatera Indonesia
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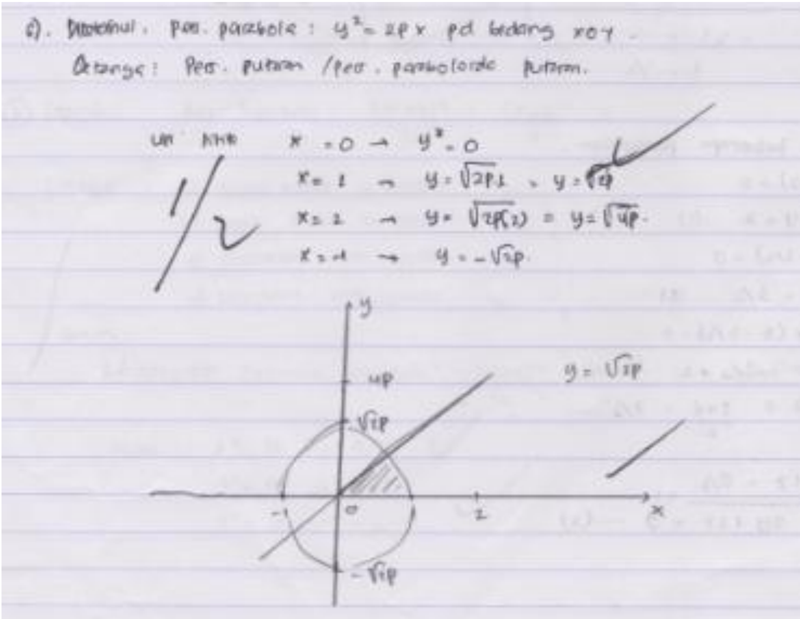
RESULT AND DISCUSSION

Data analysis result of Final Examination of Analytical Geometry obtained based on result obtained by student after doing Final Exam Semester Even 2016/2017. Data obtained in the form of a written answer sheet that is the result of student work on the questions given by the exam supervisor. Problem to be analyzed is about parabola and hyperbola problem.

Here is an example of questions and answers Final Exam Semester Even Academic Year 2016/2017 and its completion on parabolic material:



Picture 1. Student's Answer (Low Ability) On Parabolic Material

Based on Figure 1 it is known that the answer of low-ability students on parabolic material is still not appropriate. Students are still mistaken in describing the satellite dish. In addition, the concept of the student about the equation of rotation on the parabola is still lacking. Students only understand the basic concepts of parabolic equations that surround the x axis. Supposedly, the equation also involves the z axis. Students have difficulty in solving the problem because students can not remember which formula to be able to solve UAS problem. This is seen in the following high-ability student responses.

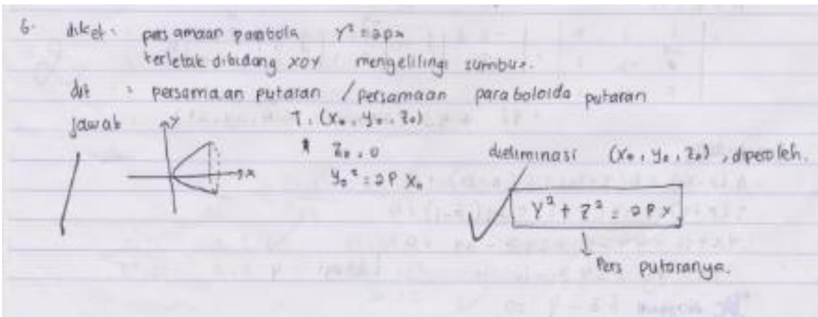
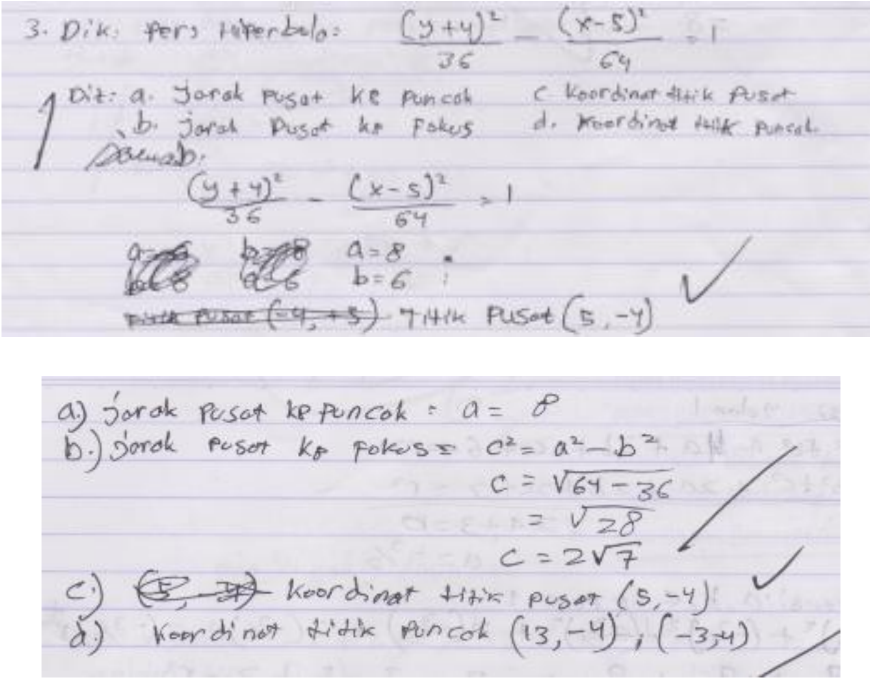


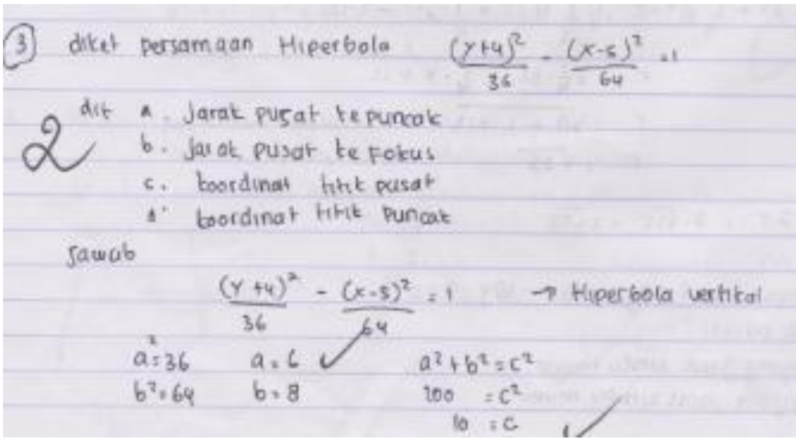
Figure 2. Student Answers (High Ability) On Parabolic Materials

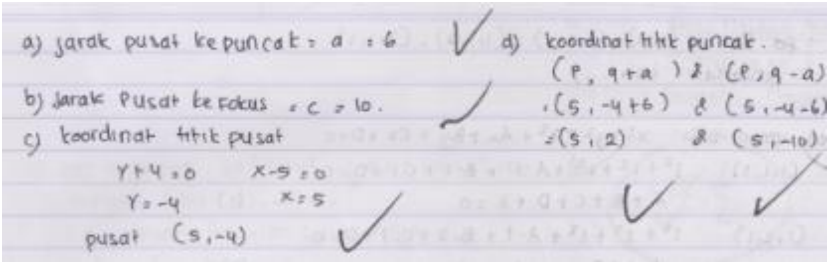
Based on Figure 2 it is known that the concept of students is correct. This can be seen from the way the students describe the parabola and analyze the given problem. Here is an example of questions and answers Final Exam Semester Even Academic Year 2016/2017 and its completion of hyperbolic material:



Picture 3. Student's Answer (Low Ability) On Hyperbole Material

Based on Figure 3 above it is known that the students are mistaken in finding the value of the coefficient c. This results in the point of coordinates of the cusp point being false. Students should apply the formula $a^2 + b^2 = c^2$. The exact concept and completion are done by the highly skilled student shown in the following figure.





Picture 4. Student's Answer (High Ability) On Hyperbole Material

Based on Figure 4 above it is known that students have understood the concept of hyperbole well and write the answer systematically. Students are able to sort the steps that will be used in problem solving.

Based on the Final Test Result of Even Semester of Academic Year 2016/2017 and interview with student, hence obtained data about difficulties experienced by student in completing Analytical Geometry that is:

a. Output / Output Difficulty.

The difficulty of output is that students have difficulty in solving the problem because students can not remember which formula to solve UAS problem. The statement is in line with the opinion Kurniawati (2013) that if students fail to remember the formulas and procedures that students memorized then thay will not successfully solve the problem.

b. Visual-Spatial Difficulty or Ordering.

Visual-Spatial Difficulties or Ordering is the students have difficulty in sorting the steps used to solve problems or understanding the concept of the matter of Final Exam in the course of Analytical Geometry. This statement is similar to Lee's opinion (Fatokun, 2016: 19), argues that the three ways in which students experience misgivings of the concept (2) Students are interested in unique explanations for various phenomena, and (3) The everyday language of society often directs students to have different views.

CONCLUSION AND SUGGESTION

a. Conclusion

Based on the results of the analysis that has been done by researchers there are some conclusions from the difficulties experienced by students, among others.

1) Output / Output Difficulty

The difficulties of output is that students unable to remember the analytic geometry formula, since the formula of analytic geometry is too long. Students tend to forget the formula of analytic geometry, when students are given practice questions by lecturers. Habits of students who are not good, students learn by mastering the knowledge of rote learning without applied to the exercise questions.

2) Visual-Spatial Difficulty or Ordering

Visual-spatial or sequential difficulties include student difficulties in sequencing the steps used to complete analytic geometry. Students have difficulty in determining the steps because students have difficulty to understand the concepts that exist in the matter.

b. Suggestion

For the next researcher should familiarize the students in doing the exercises related to understanding the concept so that students do not have difficulty when doing the test questions.

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ANALYSIS ABOUT MATHEMATIC REPRESENTATION ABILITY REVIEWED FROM STUDENT LEARNING STYLE

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Abstract

This study aims to describe the mathematical representation of students in solving problems on math problems in terms of Student Learning Styles of auditorial, visual, and kinestetik. This type of research is qualitative research. The procedure used to select the subject was randomized from two classes, with nine subjects consisting of three subjects of auditorial style (high, medium, and low), three visual style subjects (high, medium and low level), and three subject styles Kinesthetic (high, medium, and low) levels and learning styles are analyzed. Validation of data is done using triangulation time. The description of mathematical representation is based on students' work in solving math problems. There are four technical indicators of mathematical representation that are used as a measure in analyzing student work results. The method used to find out the representation of students' mathematical representation with the type of learning style in solving the problem is to solve problems and interviews.

Keywords: *mathematic representation, learning style.*

PRELIMINARY

Mathematics has an important role in various aspects of life. Many problems and activities in life that can be solved by using mathematics such as counting and measuring. Because it has an important role then math is taught in all levels of education, ranging from elementary school to college and is a science learned since ancient times until now. This is because mathematics is one area of science that can improve a person's ability to think logically, creatively, critically, scientifically, and quickly and precisely in making decisions, but to achieve it requires a good understanding and mathematical competence.

Objectives achieved in the mathematics lessons according to National Council of Teachers of Mathematics (NCTM) in 2000 are students must have five mathematical abilities namely: 1) learning to communicate (mathematical communication), 2) learning to reason (mathematical reasoning), 3) learning To solve problems (mathematical problem solving), 4) learn to engaitkan ideas (mathematical connection), 5) learn to present the ideas (mathematical representation). For mathematical representation has been included in the objective of learning mathematics in school in the Ministerial Decree no. 23 of 2006 (Depdiknas, 2007). The role of mathematics learning and mathematics objectives is very important in improving representational skills.

The ability of representation is one of several mathematical abilities students should possess. The mathematical representation itself is a person's way of thinking things out and communicating mathematical ideas in a certain way. In addition, representational skills are very useful for students to solve a problem in mathematics. As Brenner (Neria and Amit, 2004: 409) notes that "successful problem-solving processes depend on skills presenting problems such as constructing and using mathematical representation of representations into words, graphs, tables, and equations, solving and manipulating symbol."

The ability of representation is very important in the learning activities, but based on the results of literature studies conducted found that the ability of student representation is still low, one of the results of research conducted by Gilbert Febrian Marulitua Sinaga 2016, from 43 students only 13 students who complete The ability of representation, of the percentage of mastery. The ability of the mathematical representation to be observed is based on the student's learning style. Learning styles in research are divided into three categories: visual, auditorial and kinestetik.

According to Sperry Smith (Gallenstein, 2005: 28), Bruner's 3 way representation application in mathematical learning is to physically perform mathematical activities using manipulative, mental mental activity by thinking in terms of visual, auditorial or kinesthetic clues, and ultimately capable Use the number symbols with their meaning. This implies that when students want to demonstrate the ability of their mathematical representation to solve math problems, students try to recall their previous knowledge so that they can get directions to solve the problem. The guidance that students can represent is a visual, auditorial or kinesthetic activity based on the knowledge they get beforehand. From the description implies that visual learning style, auditorial and kinestetik also contribute to the students' mathematical representation.

Based on the above description, it can be concluded that there is a gap between what is desired with what is happening in the field. So it is deemed necessary to analyze students' mathematical representation abilities based on visual, auditorial, and kinesthetic learning styles in solving mathematical problems.

RESEARCH METHODS

This study included a type of literature study. Where literature study is the way used to collect data or data sources related to the topics raised in a study. This study contains about the ability of mathematical representation and learning styles of students. The sources are obtained from journals, books, articles, research reports and internet sites.

RESULTS AND DISCUSSION

Representation is a configuration. In general, representation is a configuration that can present an object in a way. Cai, Lane, & Jakabcsin (in Sabirin, 2014: 34) revealing representation is a way that a person uses to communicate answers or mathematical ideas in question. The representation generated by the students is an expression of the mathematical ideas or ideas that students display in an attempt to find a solution to the problem they are facing as a result of the interpretation of their mind (NCTM 2000: 67).

Basically in the process of learning achievement, a teacher needs to design the process or learning activities that take into account the characteristics of students such as the tendency of student learning styles. Inside each student has a different learning style to absorb and receive information. According to Bobby DePorter (2014), knowing these different learning styles has helped teachers everywhere to be able to approach all or almost all by conveying information with different learning styles. Bobby DePorter divides these learning styles into three groups: visual learning groups that access learning through visual imagery, auditorial learner groups that access learning through auditory imagery and kinesthetic learning groups that access learning through motion, emotion and physical learning. Whatever style is chosen, the learning style differences show the fastest and best way for each student to absorb an outside information. In learning, each student has different learning styles or styles to concentrate on the process, mastering difficult and new information through different perceptions. In other words each student is assumed to have a choice of individual learning styles to help them learn in a conditioned situation. So that the factors of learning style differences will likely affect the students' mathematical communication skills in resolving the questions given. According to DePorter, et al (2014) learning style is the key to developing performance in work, school, and in interpersonal situations. Ghufran (2013) states that learning styles are an approach that explains how individuals learn or how each person approaches to concentrate on the process, and mastering difficult and new information through different perceptions. According to Yaumi (2013) style or learning pREFERENCES can be seen to affect the process and learning outcomes. Style is individual for everyone, and to distinguish one person from another. Thus, in general the learning style is assumed to refer to the personalities, beliefs, choices and behaviors used by the individual to assist in their learning in a conditioned situation so as to be able to see the ability of the mathematical representation of the students in completing Math problems.

CONCLUSION

The ability of representation is one of several mathematical abilities students should possess. The mathematical representation itself is a person's way of thinking things out and communicating mathematical ideas in a certain way. In addition, representational skills are very useful for students to solve a problem in mathematics. Learning styles are an approach that explains how individuals learn or how each individual approaches to concentrate on the process, and mastering difficult and new information through different perceptions. Physically doing mathematical activity using manipulative, doing mental activity of mathematics by thinking with visual memory, auditorial or kinesthetic instruction, and finally able to use symbol of number with its meaning mean learning style come coloring ability of mathematical representation from student student.

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LEARNING TRAJECTORY DIFFERENTIAL WITH HIGH ORDER THINKING SKILLS USING REALISTIC MATHEMATICS EDUCATION

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Abstract

The goal of research is to influence learning trajectories at differential in mathematics school. The method was design research conducted in the pilot experiment. Students who are involved a student attending in XI MIA SMA10 Padang. The instrument is observation sheet, test, and local instructional trajectories which is developed in the form of student activity sheet. Based on the observation the using of learning trajectories has a success activity. The test result shows that there is improvement students' the high order thinking skills after attending the class by using the realistic mathematics education on differential. The percentage of the effect of quiz with post test of 37.0%

Keywords: *learning trajectories, high order thinking skill, realistic mathematics education*

INTRODUCTION

Differential function is one material that has very many applications both in mathematics itself, as well as in other branches of science such as in biology, physics, chemistry, technology, economics and so on. While this material is a material that is difficult to understand by students. Some studies suggest that the inability of students to gain an understanding of the concept of derivative functions, which resulted in the ability to think less. This is also supported by teachers, Thomson (2008) said that the interpretation of math teachers did not used Bloom as a guide to write higher-order thinking skills test items. This study shows teachers tend to guess the level of thinking of a problem, the percentage of teachers on average 68% make a matter of lower order thinking on the math test. The proposed learning trajectory can make the mathematical learning process more profitable (Steffe, 2004).The point of view of the learning path has not provided a framework for thinking about the learning process (Simon & Tzur, 2004).Based on the results of interviews with a number of high school students at SMA 10 Padang was the difficulty comes from problems in learning mathematics in school, including: math problems that involve many formulas and ability to think is still at a low level, understanding of mathematics just the symbols in writing on paper alone has not been able to implement it in real life, and the concept of every material in the subject of mathematics itself is not fully understood by the students in daily life. In today's mathematics learning problems in daily life are only used to apply concepts and are not used as a source of inspiration for discovery or concept formation. As a result, between mathematics in the classroom with the in everyday life as if was separated, so that students were less understanding of the concept. (I Gusti Putu Suharta: 2002). Therefore, I used mathematical learning process the realistic mathematics education in student activity sheet to explain the influence the learning process and high order thinking skills.

Problem of Research

Seeing this situation, the problem of research "do efforts to improve the quality of mathematics learning process using realistic mathematics education, especially on the differential functions as a student activity in learning and is there any interaction between students' high order thinking skills?" To answer the above problems, the approach that can accommodate both is to create learning trajectory using Realistic Mathematics Educations (RME) approach. Realistic mathematics learning begins with real-world introduction in order to facilitate students in learning mathematics. In addition, students are also given the opportunity to discover for themselves the mathematical concepts presented in everyday life so that learners can solve problems related to the derived material of function which ultimately the students are able to high order thinking level.

Research Focus

Learning Trajectory (LT) is a way to describe pedagogic and didactic aspects in lectures in mathematics. The relationship between teacher and student in aspect of pedagogic, student and the material in didactic. LT is made anticipation of what might happen, both the thinking process of students who will get the learning of mathematics. Learning trajectory used is still a hypothesis or alleged so-called LT and is a bridge between the theory of teaching and learning process in the real class (Bakker, 2004). Based on the theory of teaching, formulated various mathematical ideas that become the focus in the learning stage. The contextual problems corresponding to the mathematical ideas were then developed for classroom derived learning. This is supported from the research (Arnellis, 2016) states that learning trajectory developed effectively used in studying calculus especially differential to develop the ability of mathematical thinking of high level of student. This paper discusses how to have produced learning trajectory (LT) which valid based on Realistic Mathematic Education so that it can be used to build students' high thinking ability in understanding differential function. In this study, the design of the LT used as a guideline implementation of learning activities that are implemented in the form of lesson plans so as to serve as a guide research design.

High Order Thinking Skills (HOTS) is ability to think high level defined was by Tran Vui (2001) as follows higher order thinking occurs when a person takes new information, analysis rearranges and extends this information to create a purpose or find few possible answers. With HOTS students will learn more in-depth *knowledge is thick,* students will understand the concept better and can distinguish the idea or the idea clearly, argued with good, capable of solving the problem, able to construct the explanation, capable of hypothesized and understand complex things become more clearly. This shows that can be studied, HOTS can be taught on the students, with HOTS troubleshooting capabilities students can be improved. Furthermore said that there is a difference learning outcomes that tend to memorize and learning HOTS that uses a high level of thinking. Thinking means using analytical capability, evaluation, and such create required in daily life.

To develop high-order mathematical thinking skills LT students need to be implemented on learning, in accordance with the characteristics of students learning. In implementing LT accompanied by appropriate student activity sheets that enable students to develop high order mathematical thinking skills. The result of Sarah's research (2006) showed that the submission of high-level questions has an effect on the improvement of student ability in handling mathematics problems that require high order thinking**.**

Realistic Mathematics Education (RME). Students can follow the four stages of developing the model by creating, a concrete model, then a semi-abstract model, and finally creating an abstract model. Through the principle of developing the model independently, students are expected to solve realistic problems given. According to Freudenthal (in Gravemeijer, 1994a), the activity of mathematics means being associated with reality through problem situations. The term "reality" means that the problem situation is best demonstrated to learners. So what they learn is no longer an abstract thing, but it becomes concrete for learners.

In Realistic Mathematics Education, mathematics is learning activities are conducted by using real world and formed the ideas of learners in doing mathematical problems. According to Freudenthal (Gravemeijer, 1994), RME also has five characteristics, namely:

1. Using heading contextual problems*;* Learning's exactly what happened here with contextual issues to enable learners to use previous experience and knowledge of its beginning directly, starting from the formal system.
2. Using heading vertical instruments such as models, schematics, diagrams, and individuated*;* This means that learners make their own models in resoursces' contextual problems is is the relationship between the real-world situational models screened acres relevant to the environment of learners into the mathematical models.
3. Using heading the contribution of learners*;* A great contribution in the learning process is was much bigger to come from the learner, not the teacher. This means that all the thoughts or opinions of learners acres noticed or appreciated.
4. Interactive learning process*;* Interaction forms such as negotiation, explanation, justification, approval, question, or reflection acres used to achieve the informal mathematical knowledge form that the learners find themselves.
5. Related to other topics*;* In RME the integration of mathematics learning units is essential. By integrating it will make it easier for learners to solve the problem.

To see the implementation of the above characteristics, the use of RME is implemented on the activities of students in learning process on student activity sheets. Freudenthal (1991) discusses the possibility of bridging this formal informal gap in learning or making introducing the concept is easier as he suggests don't teach a formulating before the introduction of Calculus through a specific learning process

METHODOLOGY OF RESEARCH

General Background of Research

The method used is design research (Cobb & Gravemeijer, 2008). Design research consists of "… a family of methodological approaches in which instructional design…." which is done in teaching experiment stage. During the learning experiment, LT serves as a guideline as a researcher what will be focused in the learning process, interview and observation. Researchers need to adjust the LT with learning activities that are guided by the lesson plans. The research approach is started the experiment, that is thinking about the learning path that will be done by the students.

Sample of Research

Sample of research come from students who study mathematics in class XI MIA SMA 10 Padang in the form of learning activities of learners.

Instrument and Procedures

The main research instrument was the LT differential function. Data were collected mainly from student written responses to learning tasks in student activity sheet. The tasks included five quizzes for assessing result of at the end in student activity sheet. The effectiveness of LT performed post-test. Preparation of test questions based on HOTS indicators. Furthermore data from post-test result is analyzed quantitatively. The purpose of this analysis is to investigate the influence whether the learning tasks in quiz of student activity sheet can be achieved by the learners.

Data Analysis

Data were collect from activity of RME in student activity sheet is analyzed quantitatively with percentage technique. The purpose of this analysis is to know whether the characteristics of RME can be achieved by the student. Data analysis based on post test is done by giving a quiz at the end of activity in solving the problem of HOTS and strategies used in accordance with predetermined indicators. Quantitative data processing is done through two main stages.

1. The first stage: test statistics requirements needed as the basis in the hypothesis testing, namely normalitas test the spread of the data and test the homogenitas varians.
2. The second stage: test whether the the influence of the interaction to high order thinking skills of the differential function in accordance with quiz at the end of learning activity by using in RME

RESULTS OF RESEARCH

Description of Data

Description of data in student activity sheet and HOTS students' score were obtained after being given learning process on the sample, which is student in the class of XI MIA of SMA 10 Padang is followed by figure below:

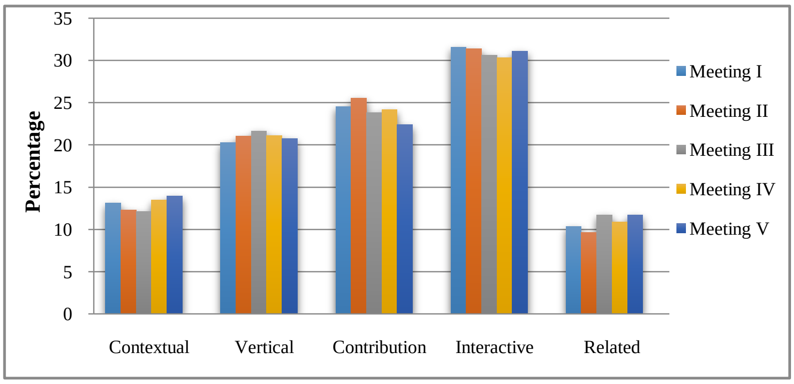


Figure 1: Comparison of Distribution of Student Activity in Each Meeting

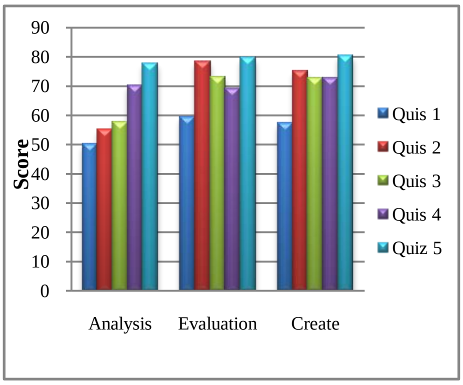
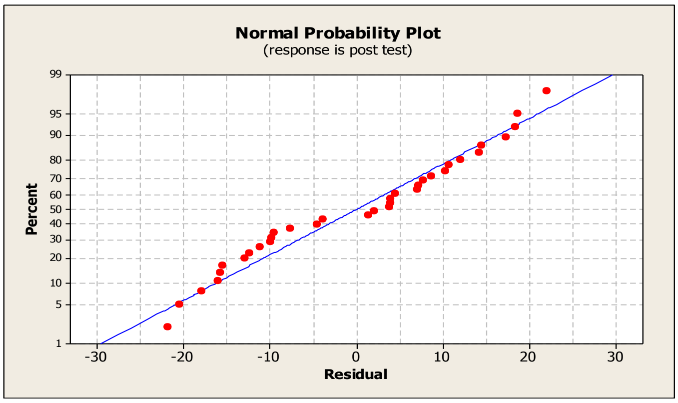


Figure 2: Comparison of Development of Quiz Student's

Based on the figure above, described are about the development of student activity during the study. Data obtained from the quiz of five meetings on the learning process with RME approach can be seen in the above diagram and the development of student activity are fluctuates. In this case there are two of the characteristics in RME, using contextual problem and related to other topics have low percentage. Furthermore development of students' high order thinking ability, the score is at value of 50 to 80, although there is a decline in the value of the evaluation indicators at Quiz 3 and 4.

Analysis of Data

The analysis of data aims is done through two main stages.
The first stage: test statistics requirements needed as the basis in the hypothesis testing, namely normalitas test the spread of the data.



In the above diagram is shown the normal distribution if the plot follows a straight line

To see the influence of the interaction to high order thinking skills of the differential function in accordance with quiz at the end of learning activity by using in RME. Consider the following table

Table 1. Regression Analysis: Post Test versus Quiz

Source	DF	**SS**	**MS**	**F**	**P**
Regression	1	3130.23	3130.23	18.79	0.000
Error	32	5330.71	166.58		
Total	33	8460.94			

The regression equation is post test = 31.6 + 0.336 quiz

Predictor	Coef	SE Coef	T	P
Constant	31.634	5.165	6.12	0.000
Quiz	0.33632	0.07759	4.33	0.000

S = 12.9068 R-Sq = 37.0% R-Sq(adj) = 35.0%

Based on above table is obtained by the value of constant coefficient 31.63 and dependent variable coefficient (quiz) 0, 3363 then obtained regression equation. Post test = 31.63+ 0.3363 × quiz. It means that there is a positive influence between the quiz and the post test value. This means that each increase of 1 unit of quiz variable resulted in an increase in post test value of 31.63+ 0.3363 = 31.9663. Based on the value of P that is 0.000 compared with $\alpha = 0.05$ means there is influence between quiz and post test. That is there is significant influence between quiz variable with post test variable. In consider the value of R-sg = 37.0%, means the effect of quiz with post test of 37.0%, besides there are other factors that affect the post test variable.

DISCUSSION

The process of analyzing and explaining are not only on the factors that support the success of learning, but also on some allegations of unresponsive learning. After learning by apply the LT of function derivative with RME approach which begins with contextual problem, horizontal mathematization, and vertical mathematization that runs well in accordance with the plan and learning objectives to be achieved. Activity at first meeting 1 aims to introduce the basic concept of derivative function that is given two problems in the real world. Based on student activity in worksheet, using contextual into problem and related to other topics are low percentage. At the end of first meeting was given a quiz, and the result of mean score quiz 55.5. The second meeting the learner began to solve the contextual problem related to derivative in their own way. This is a situational stage and learners perform a process of horizontal mathematization (Gravemeijer: 1994).Score in second mean score quiz is 69.5. Contextual problems are given at meeting 3 according to the learning objectives. The students are able to make a graph of function. After being able to develop models informally (horizontal mathematization) become to differential form, student are to be interactive, this is showed the highest percentage 31.016%, and score of mean quiz is 67.92. The fourth meeting, the learners are directed to think formally (vertical mathematization). In vertical mathematization, learning also begins with contextual problems, but in the long run learners can devise specific procedures that can be used to solve similar problems directly without the help of context. Based on student activity, percentage of related to other topics were decreased to be 10.9%, and mean score of quiz were 70.75

Learning activities carried out at the final meeting were given few real problem in other case student using related to of a derivative formulate. The mean score of quiz were 79.17. In general learning with the RME approach is a learning that requires the activities of learners. This is evident from the involvement of learners in various activities such as contribute of learner, and presentations in front of the class to explain their work and interactive learning process have high percentage. In learning using the RME approach, each learner is free to use their own strategy (the use of student contribution results) in solving the problems contained in the student activity sheet. In this study, seen from the work of student activity each learner has a strategy or own views that are different from the opinions of his friends in class discussions. Activities to develop students' understanding of logarithms are used as examples of RME design principles. Also Geist, Webb & van der Kooij (2011) attest to the usefulness of RME in informing a more student-centered design in mathematics class.

The post-test results showed that there is a influence in students' high-order thinking skills on the derivative function. The effect of between mean score of quiz and post test only 37.0%, besides there are other factors that affect the post test variable. Therefore, some students were explored that the value of the test post was in the low, medium, and high group. The students delivered a number of opinions after the post test activities.

Student 1: I understand the real problem, but it is difficult to understand mathematics model, to the
reason of this "just adds me to be confused, I can’t analysis".

Student 2: I find the way, but it is confusing and requires many prerequisites, associated with
Mathematics lesson in class X

Student 3:"... I can’t state its function, because I don’t evaluate a model and the relationship
between the real-world situational models, but if it's a test material. I should be ready to

study hard."

Student 4: "It made me have to discuss with my friend to think about how derived formulas to
transcendent functions".

Student 5: "The material is highly relevant and helps create the mind and think critically and
creatively".

Student 6: "I think the teacher should focus more on the worksheet by taking notes more details
to learners and students can interact ".

Student 7: "Maybe certain aspects should be explained before the question is asked".

Student 8: Given hints of relevance to other topics. For example some other field problems in
one theme is derivative

Student 9: Remarked, "Your program in student activity sheet was very challenging. I realized that
I have a shortage in mathematics"

Overall, students feel that activities using LT in the form of worksheets with RME help them understand the basic concept of differential function better. "LT is useful in terms of revising the formal aspects of the derivative that I learned in previous lessons". But there is a gap between a student's prior knowledge and the formal world of Calculus (Tall 1991; Tall & Meija-Ramos 2004) Some students interested in RME investigative activities because they help in HOTS thinking. When asked about how well the activities can help in their preparation for the formal form of the derivative function?, some students agree as shown by the "good" response. Suggestions for improvement include giving more detailed notes and explanations. When asked about learning difficulties, students mention the definition of differentiation by using a limit, a function graph to indicate there are differentiated functions and some are not. All the difficulties mentioned are related to conceptual understanding, since they have always used direct differential formulas

CONCLUSION

Based on the results of the data analysis, concluded*:*

1. Student activity in the derived function LT learning using the RME approach has increased by the first meeting to the fifth meeting, although there are some activities that increase unstable.
2. The potential impact of functional derived LT is to improve the thinking ability of high-level learners. In the beginning learners are still difficulty in understanding the material and solve contextual problems. After doing research like this, the ability to think learners had been increased. That is, if learners learn with LT like this then it will increase the ability of high-level learners.
3. There are many real problem in physic, chemistry, biology, economics, and so on, how to create learning trajectory so that related to topics in differential

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IMPROVING COMMUNICATION SKILLS STUDENTS APPROACH TO M-APOS AIDED MIND MAPPING

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Abstract

The ability of mathematical communication is the way to share ideas and explain an understanding to others or other learners.At the high school level, the mathematical communication ability of the learners is less attention, the lack of attention is seen from the weakness of students' ability to communicate mathematically.The learning process applied by teachers is less support to improve the ability of mathematical communication.This study aims to explain the M-APOS approach with the help of mind mapping to improve students' mathematical communication skills.The modified AP-APOS approach of APOS theory consists of actions such as actions, processes, objects and schemas.Mind Mapping is one of the stimulus to be used in component of M-APOS approach to improve students' mathematical communication ability.Indicators of mathematical communication capabilities consist of (1) Stating situations, drawings, diagrams or real objects into symbol languages, ideas or mathematical models;(2) Explaining ideas, situations, and mathematical relations both orally and in writing;(3) Listening, discussing, and writing about mathematics;(4) Reading with the understanding of a written mathematical representation;And (5) Revisiting a mathematical description or paragraph in its own language This type of research is a literature study.

Keywords: M-APOS approach, *Mind Mapping,* Mathematical Communications Capabilities

PRELIMINARY

The 2013 curriculum was developed using several philosophies one of which education is to build a present life and a better future from the past with various intellectual ability, communication skills, social attitudes, care and participation to build a better society and nation life. Curriculum 2013 has the competence of graduates in one of them is to create a communicative learner. Problems identified in learning mathematics obtained information that the mathematical communication skills of learners need to be improved again. Learners should be able to convey ideas, opinions that come from within them either in the form of drawings, diagrams, graphs or writing mathematics to be delivered to others either verbally or in writing, because in mathematics there are many symbols that need To be understood. The genetic decomposition of a concept is a structured set of mental constructs that may illustrate how the concept can develop in the minds of individuals (Asiala et al 1996)

Basically, the success of a learning is influenced by many factors, such as learning model, learning strategy or learning material. Information received should encourage learners to develop the ability to think and communicate in processing the problems encountered.

Rippi Maya and Utari Sumarmo (2011) in his research say there are some problems that there are some difficulties in solving mathematical problems, namely:

a. Learners can not produce an example
b. Learners can not explain the concept to a simpler concept form
c. Learners do not understand the standard mathematical notation and language math
d. Learners do not know to start a proof
e. Understanding the concept of learners is not satisfactory to start a proof
f. Lack of understanding of students to the mathematical notation that they use are not clear or membingun g kan language of mathematics
g. Learners can not look for links between concepts, definitions, theorems and between relevant theorems and definitions.

Seeing the above problems then the teacher should be able to create a learning environment that centered on learners who can improve mathematical communication skills of learners. Solutions that can be used are learning to use the M-APOS-assisted approach *of mind mapping.*

The APOS theory was introduced by Cottrill et al (1996). This theory focuses on analyzing internal mental structures and mechanisms constructed and used by individuals because he is thinking of mathematical concepts. All mathematical conceptions can be understood as actions, processes, objects or schemes. (M. Arnawa, 2007). There are four characteristics of APOS theory, namely (1) that mathematical knowledge is constructed through mental constructs: actions, processes, objects and organizing it in schematics. (2) using the computer. (3) using cooperative learning groups and (4) using the ACE learning cycle (activities, class discussions and exercises). The M-APOS approach is a modification of the APOS approach that not only uses computers, but can be other learning resources, such as LKPD, textbooks and so on.

Assessment of students' mathematical communication ability can be measured based on indicators of mathematical communication ability of learners. The purpose of this study is to describe the approach of the M-APOS aided mind mapping can improve communication skills mathematical learners.

METHOD

This study uses literature study research, explained that the M-APOS-assisted approach of mind mapping Can improve the mathematical communication ability of learners. Activities undertaken in this literature study is, literature analysis approach to M-APOS, mind mapping literature analysis, literature analysis mathematical communication skills and analytical approach to M-APOS relationship mind mapping aided in improving the communication skills of mathematical learners.

RESULTS AND DISCUSSION

The APOS approach has been widely used in research, as a developmental perspective or as an evaluation tool even both. The APOS approach focuses on a model of what might happen to a person's mind as he is learning to try a mathematical concept and use this model to evaluate the success and failure of learners in solving math problems.

a. **M-APOS Approach**

The APOS theory (Dubinsky & McDonald, 2001) suggests that each individual must have the proper mental structure to understand the mathematical concepts. The mental structure refers to the possible actions, processes, objects and schemes needed to learn the concept. (Dubinsky, 2010; Weller et al, 2003). According to Weller, Arnon and Dubinsky (2009) the components of the M-APOS approach are:

1. Action

Action is a reaction to a given stimulus where the individual feels as an external. In addition the concept of this action is when learners perform calculations and transformation of mathematical objects as a result of external stimuli such as entering numbers for variables in the formula, he can also perform many step algorithms by triggered by the previous step (Marcela, 2009). Action is a transformation of mental objects to acquire other mental objects. A person is said to experience an action when a person is focusing his mental processes on trying to understand a given concept.

2. Process

The process is the mental structure that performs the same operations as the action, but the whole is done based on individual thinking, or when learners can reflect actions, two or more processes can be coordinated to form new processes (Marcela, 2009).

Individuals who have been able to decipher the concept of constructing process or even reverse steps of transformation without actually doing it. In contrast to the action, process perceived by the individual as a matter of internal and under the control of the individuals themselves.

3. *(Object)*

The object is that if one becomes aware of the process as a totality, be aware that the transformation can act either it explicitly or in the imagination of a person can be said the individual has packed the process into a cognitive object. Or when the need arises to transform the process and can take action to find out the results of the actions and processes that have been done (Marcela, 2009).

In this case it is said that the process has been summarized (encapsulation) into a cognitive object. A person is said to have had a concept of a concept of mathematical object if he had been able to treat the concept as a cognitive object which includes the ability to take action on the object and provide a reason or explanation of its properties. Then the individual also has been able to parse an object back into a process as it came from when the nature of the object will be used.

4. Schema *(Schema)*

A scheme A mathematical topic often involves many actions, processes, and objects that need to be organized and connected into a coherent framework. Meanwhile, according to Marcela (2009), the scheme is a coherent structure of a concept that has been studied that can be used in problem solving.

Based on the theory of APOS and the teaching and learning hypothesis is a recurring cycle consisting of three components of ADL or ACE: (A) activities, (C) class discussions, and (E) exercises performed outside the classroom (Asiala, et al, 1996). For this discussion that is when learners do not have prerequisite construction, it becomes very difficult for them to develop the scheme. For that there should be a special emphasis on scheme development, giving learners the opportunity to experiment with different types of sets and binary operations so that they develop flexibility in thinking about other existing structures.

According to M. Arnawa (2007: 145) states that differences in learning outcomes of learners using APOS compared to traditional ways are:

No	APOS Theory	Traditional
1	Topics are designed on the step-by-step development of mental actions, processes, objects and schemes. Learners are actively involved in learning mathematics. Mathematical ideas (definition, lemma and theorem) found in learners through the findings of facts in laboratory activities	Topics not specifically designed generally refer to textbooks or notes, learners receive information passively, mathematical ideas are given in ready-made form.
2	The role of the lecturer / instructor as a facilitator, ie support group or whole-class learning, *scaffolding,* for example asking or giving directions.	The role of lecturer / instructor as a transformer of knowledge, ie lecturers / instructors directly explain the idea of mathematics
3	The existence of multi-direction interaction between students and also students and lecturers. Learners learn from colleagues through groups and discussions	One or two ways of interaction involving the teacher

b. ***Mind Mapping***

Mind Mapping is a learning strategy that emphasizes the research process and the recording of what is thought to combine text and images are visualized in the form of a map. This strategy will help learners to store information in the cognitive structure of the brain to make the information more durable in memory. It can increase students 'mastery of learning materials and improve students' mathematical communication skills in absorbing information from everyday life into math languages with their respective mind maps.

The mind map (mind mapping) is how the brain processes information delivered in the form of communication. Communication requires the brain to seek, sort, choose, formulate, tidy up, organize, connect and mix the ideas with words that have meaning so that they can be understood. They can be expressed in pictures, symbols, images (impressions), sounds and feelings.

Bobbi De Porter (2004: 153) suggests that mind maps are the whole brain utilization technique by using visual images and other graphical infrastructure to form an impression. Tony Buzan (2008: 6) also found the mind mapping is the easiest way to enter information into the brain and to retrieve information from the brain. Based on the above opinion, it is concluded that mind map helps learners to utilize the brain optimally so that information last long in memory. The use of color, movement, images, contrast, organizational decisions, the information encoded in our mental map (Eric Jensen, 2008: 134). Michael Michalco in Tony Buzan (2010: 6) states that mind maps will help:

1. Activate the whole brain.

2. Takes the mind out of mental tangles.
3. Allows us to focus on the language.
4. Helps show relationships between sections of mutually exclusive information.
5. Provides a clear picture of the whole and the details.
6. Allow us to group concepts, help us to awaken them.
7. It requires us to focus on the subject that helps divert information from short-term memory to long-term memory.

Steps in making mind maps, (Bobbi De Porter, 2009: 157) and (Buzan: 21-23) can be summarized:

1. Make a horizontal mind map.
2. Starting from the center of a piece of blank paper.
3. Use an image for the central idea.
4. Use color on all mind maps.
5. Make the branches of the mind map curved rather than straight lines.
6. Use one key in the line.
7. Write important ideas with bigger letters.
8. Write down the keywords / phrases in each branch, develop them to add details.

Based on these steps the learner is required to communicate the material as a whole to the map formulated from the central topic to the more detailed branches. Thus, it can be identified the advantages of this mind map, ie

1. Learners can communicate clearly the central topics to the more specialized and demanding learners explore the capabilities they have to be able to think more creatively and systematically.
2. Balancing the left brain and right brain learners.
3. Gives a clear picture of the whole and the details.

Then, while the benefits of learning to use a mind map that is (Bobbi De Porter, 2009: 47):

1. It's flexible because whenever you can add information.
2. Your attention becomes focused because you are concentrating on big ideas, and still do not forget the small details.
3. Your understanding increases and gives you great notes for study.
4. And just admit it is fun!

c. **Mathematical Communication*Ability*of Students**

In the context of learning, communication is an important means for a teacher in conducting a learning process where the teacher will build understanding of learners about the material to be taught. Through teacher communication as the source of conveying information to a receiver (learners) by using symbols of good oral, written, non-verbal language. Instead, learners will convey various messages as a response to the teacher resulting in two-way communication in order to improve communication success to achieve learning objectives.

Mathematical learning also requires communication ie mathematical communication. Mathematical communication according to the Ministry of Religious Affairs in Fauzan (2010: 26) is "the ability to declare and interpret mathematical ideas orally, written, tables or graphs". In further, according to the National Center for Teaching Mathematics (NCTM) in Fauzan (2010: 27), revealed the mathematical communication is:

1. Communication where mathematical ideas exploited in a variety of perspectives, helping to sharpen the thinking of learners and improve the ability of learners in mathematics see various linkages material.
2. Communication is a tool to "measure" the growth of understanding, and reflect an understanding of mathematics learners.
3. Memalui communication, learners can organize and condition of their mathematical thinking.
4. Communication between learners in the learning of mathematics is essential for: constructing mathematical knowledge, the development of problem-solving and reasoning improvement, improving self-confidence, and improved social skills.
5. *"Writing and talking"* can be a very significant *(powerful)* to form an inclusive mathematics community.

Masykur and Abdul (2009: 51) say that communication that occurs in mathematics can occur in the real world, the abstract structure of a system, and mathematics itself is a form of communication used for the development of mathematics. NCTM related to the development of mathematical communication skills, there are some benefits gained by learners, namely (ahmad fauzan, 2010: 28):

1. Model situations with oral, written, drawing, graphically, and algebraically.
2. Reflect and clarify in thinking about mathematical ideas in various situations.
3. Develop an understanding of mathematical ideas including the role of definitions in mathematics.
4. Using reading, listening, and writing skills to interpret and evaluate mathematical ideas.
5. Examine mathematical ideas through conjecture and convincing reasons.
6. Understand the value of the notation and the role of mathematics in the development of mathematical ideas.

Baroody there are at least two important reasons that make communication in mathematics learning should be the focus of attention, namely (a hmad fauzan, 2010: 27):

1. *Mathematics as language,* mathematics not only as a tool to think, solve problems, tools to find patterns, or completing math problems, but also *"an invaluable tool for communicating a variety of ideas Clearly, precisely and succinetly.*
2. *Mathematics learning as a social activity,* as a social activity in mathematics learning, interaction among learners as well as teachers and learners' communication is an important part for the *"nurturing of children'smathematical potential."*

The communication role of mathematics in mathematics expressed by the Greenes and Schulman, namely (ahmad fauzan, 2010: 28):

1. Central power for learners in formulating mathematical concepts and strategies.
2. Capital success for learners to approach and investment in the exploration and settlement of mathematics.

3. Containers for students to communicate with their friends to obtain information, share thoughts and meetings, brainstorming, assess and refine ideas to convince the others.

Assessment of mathematical communication ability of learners that can be measured based on indicators of mathematical communication ability of learners. (Utari, 2010; 4) that is:

1. Stating situations, drawings, diagrams, or real objects into language, symbols, ideas, or mathematical models;
2. Describe ideas, situations, and mathematical relations both orally and in writing;
3. Hear, discuss, and write about mathematics;
4. Reading with the understanding of a written mathematical representation;
5. Revisit a mathematical description or paragraph in its own language

Based on the above, M-APOS approach can improve students' mathematical communication ability. It can be seen from the component approach developed M-APOS, in the presence of M-learning approach APOS this mind mapping assisted learners can train himself in accordance with the indicators contained in the mathematical communication skills. Indirectly, APOS M-aided approach of mind mapping can be used as a means to convey or understanding of the concept or teaching materials (Edi and Ali, 2003: 6). Each component of the M-APOS-assisted approach of mind mapping are presented to encourage students to communicate mathematically in expressing concepts that they find and understand.

d. **RelationshipApproachM-APOSAssisted*MindMapping*ImproveCommunication Skills Mathematical**

The M-APOS approach can detect further who mastered the concept of mathematics better, ie if one can further explain the concept then it is at a better level. In the meantime, if M-APOS's mental construction of a mathematical concept has been well constructed by individuals, it can be used to make a solid prediction of the individual succeeding in using the mathematical concept in solving a problem.

M-APOS approach components can be combined with mind mapping strategy. It aims to learners able to draw conclusions based on their own thoughts. Basically, mind mapping is how the brain processes information. Thus, the M-APOS-aided approach of mind mapping can improve mathematical communication skills. It can be seen from the component approach assisted M-APOS developed *mind mapping.* The components are :

1. Component *action* (action) aims to make learners are able to construct their own knowledge based on problems given. Indirectly, the students are required to be able to organize and consolidate their mathematical thinking and communicating. In the components of this action learners do the various activities of which complements the questions provided by the teacher, to register what was understood, noting what is being studied, calculate appropriate teacher-directed, tells the experience of the everyday life of the concepts learned, citing a concept , Pairing or matching, reading about concepts to be learned, memorizing or beginning to understand the concepts of a learned mathematics and so on. Activity at this stage of this action could improve the indicators of mathematical ability is declared the situation, drawings, diagrams or real objects into the language of symbols, ideas or

mathematical models (1), read with understanding a written mathematical representation (4);

2. Process components intended that learners are able to seek and find through a systematic process of thinking. Indirectly, students were asked to express mathematical ideas in a coherent and clear. They Able to express opinions orally and in writing. Thus, students were asked to communicate orally and in writing in the learning process. At this stage of the process the learner reclaims what is understood, defines something into the language of mathematics, calculates according to his own thinking, explains or describes lightly a mathematical concept, examines, conducts experiments (exercises) with other things, plans what to do To solve a mathematical problem, to exemplify what is already understood by others, to operate a concept that has been understood and many other activities. From some of the activities undertaken it can improve the mathematical communication ability of some indicator that is revealing a description or mathematical paragraph in its own language (5), stating situations, drawings, diagrams or real objects into symbol language, idea or mathematical model (1) , Reading with the understanding of a written mathematical representation (4), listening, discussing and writing about mathematics (3), explaining ideas, situations and mathematical relations in oral or in writting (2);
3. Object component intended that learners are able to conduct group discussions and serve as a forum for students to communicate with the their friend to obtain information. In the component of this object learners perform some of the activities of which describe or explain in words clearly and in detail, identify or define the characteristics of an object (object), named something with a variable, classify, categorize, classify and compare something, Analogy, making something new based on existing examples, applying a principle, calculating or predicting, considering, making hypotheses, generalizing, expressing opinions, imagining, fantasizing, maintaining opinions accordingly that have been understood and so forth. In the object components, it can improve the indicators of the ability of mathematical communication among them to explain ideas, situations and relationships mathematics verbally or article (2), read with the understanding of mathematical representations in writing (4), declare the situation, drawings, diagrams or real objects into the language of symbols , ideas or mathematical models (1), Reveal back one paragraph description or mathematics in the language itself (5), Hearing, discuss and write about mathematics (3).
4. Component *Schema* (scheme) aims to make students able to use mathematical language appropriately in various mathematical expression based on real objects, pictures, diagrams and tables are presented. It aims to make the students capable of making communication as a tool to "measure" the growth of understanding, and reflect an understanding of mathematics learners. Then, these components are presented with *mind mapping* so that the information communicated through the mind map will be more durable in the cognitive structure of learners. The scheme train the learners to perform synthesizing activities combines different meanings so that it is a harmonious unity,

connects or associates various mathematical concepts, reveals cause, creates models in accordance with the understanding of mathematical concepts, designs and creates relationships of several mathematical concepts, makes sketch, create maps, charts, or diagrams, organize and compile into a single section so regular. In this regard could improve the indicators ability mathematical communication among reading with the understanding of mathematical representations in writing (4), To express a mathematics paragraph in the language it self (5), To explain situation, drawings, diagrams or real objects own into the language of symbols, the ideas or mathematical models (1), describes ideas, situations and relationships verbal math or writing (2).

COVER

The study describes the approach of the M-APOS mind mapping it improves mathematical communication skills of learners. The advantages of using M-APOS theory for learners are active involvement (social interaction), the opportunity to communicate mathematically, the informal classroom atmosphere of freedom to ask questions, the closer relationships of learners with teachers, the opportunities to solve mathematical problems and instructors attend continually the learners access their respective abilities especially their mathematical ability.

An approach should facilitate the development of mental structures on process and level objects. While the focus on symbolic structures should aid the conception of objects. If the scheme organizes and correlates the relevant actions, processes and objects, so this should be part of the learning. Theoretically approach aided M-APOS mind mapping can improve mathematical communication skills of learners, as evidenced by each activity on the M-APOS increased support for each indicator kamampuan existing mathematical communication.

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MINIMIZE STUDENTS MATHEMATICS COMMUNICATION ERRORS WITH REALISTIC MATHEMATICS EDUCATION (RME) APPROACH

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Abstract

This study aims to examine a learning approach that can be minimize students' mathematics communication errors in solving mathematics problems. Difficulties of students in learning mathematics seen from the error in solving mathematics problems. Mistakes occur because students have difficulty interpreting information and conveying ideas from a mathematics problem in writing. Ideas must be conveyed through processes so that students are expected to find the right strategy in solving a mathematics problem. Today, students have not fully maximized their mathematics communication skills in solving a mathematics problem. This is because learning designed by teachers does not help students maximize their mathematics communication skills. As a result, students make mistakes in communicating the information provided in solving mathematics problems. The solution is used as an alternative to minimize the communication errors of mathematics communication through Realistic Mathematics Education (RME) approach. The RME approach encourages students to understand and explain contextual problems, solve problems, compare, and conclude. Mathematics activities built on the application of the RME approach in learning can help teachers maximize mathematics communication skills and minimize student errors in solving a mathematics problem. The research method used research literature study by collecting various information about Realistic Mathematics Education (RME) approach and mathematics communication errors.

Keywords: Realistic Mathematics Education (RME) approach, mathematics communication errors

INTRODUCTION

Mathematics learning in the 2013 curriculum give emphasis skills in the application of mathematics, both in everyday life and in helping to learn other science. Given the importance of mathematics, many ways that can be done in an effort to improve the quality of mathematics education in order to create a human who has knowledge and expertise in the field of mathematics, among these efforts is to maximize the way students in obtaining learning. In the process of learning mathematics should be more than just receiving information, remember and be able to solve a problem. However, students must actively find ideas to really understand and ready to apply the knowledge they have. Activity and readiness of students in learning is one of the factors that influence success in creating learning activities.

Students' success in learning is usually measured based on student learning outcomes. However, today's student learning outcomes are still far from being expected. This can be seen based on the facts from the results of research Trens In Mathematics and Science Study (TIMSS) 2011 in Lukman Jakfar, et al. (2015), junior high school students ranked 36 out of 39 countries in the world. The study results of the Program for International Student Assessment (PISA) also shows that Indonesian students are ranked 64 out of 65 countries in the world. This result is not much different from TIMSS 2015 which was just published by Kemendikbud December 2016 and showed the achievement of Indonesian students in Mathematics field ranked 46 from 51 countries in the world. It proves that student learning outcomes Indonesia is still very low compared to other countries in the world.

According Mulyadi (2010), low student learning outcomes is one indication of symptoms of learning difficulties. Learning difficulties can be interpreted as a condition in a learning process characterized by certain obstacles to achieve learning outcomes. Difficulties of students in learning mathematics seen from the error in solving mathematics problems. Soedjadi, et al in Moma (2008: 24) said that difficulty is the cause of the error. Error students in solving mathematics problems including one of the factors that affect the low learning outcomes. Maya and Utari (2011) revealed in his research that students do not understand the standard mathematics notation and language mathematics, the lack of students' understanding of the notation and the mathematics language used is unclear or confusing and the students can’t find the connection between the concepts, definitions, the relevant theorems in solving mathematics problems. And according to Zetriuslita (2013: 127) students difficult to write or model what is known, who was asked from a given problem. In general, the error that occurs in the solution of the problem is not just the end result but also the process of completing it. The activity of processing information based on the given problem requires the students' mathematics skills.

One of the most important mathematics skills in solving the problem is the skills of mathematics communication. According to BSNP (2006: 140), communication includes one of the abilities that become the objective of learning mathematics in the curriculum that is communicating ideas with symbols, tables, diagrams, or other media to clarify the situation or problem. Likewise with the 2013 curriculum also has the competence of graduates is to create students who are communicative. The skills of communication in mathematics is the skills to include and contain opportunities to communicate in the form of: reflecting real objects, images, ideas, or graphs; modeling situations or problems in everyday life, and responding to a problem in a convincing argument through the language of mathematics.

The skills of mathematics communication has an important role in learning mathematics, because the skills of mathematics communication will help students in sharpen the way of thinking and sharpen the skills to see the various relationships of mathematics material in everyday life. Armiati (2011) revealed that the skills of mathematics communication is still a weak point of students in learning mathematics. Furthermore, Fauzan in Zetriuslita (2013: 129) suggests the low level of students' mathematics communication skills caused by the practice of learning in schools that indicate a "shift" of mathematics learning objectives. NCTM in Yosmaniarti, et al (2012: 66) asserted that in order to support effective learning, teachers should build mathematics communication in the classroom so that students feel free to express their ideas and answers. Without the skills of mathematics communication then students can not solve the problem even though students have high problem solving skills. Thus, the error in solving mathematics problems is influenced by the mathematics communication skills possessed by the student.

In connection with the above, it is necessary to consider how to develop students' communication skills in the learning process. One of them by applying a learning approach that uses the application of mathematics in everyday life is the approach of Realistic Mathematics Education (RME). This is in line with the opinion of Nanik and Budi (2013: 3) in his research reveals that the application of Realistic Mathematics Education (RME) approach in learning can involve students directly so as to improve thinking and implementation because students really understand the concept being studied. In line with that opinion, the application of Realistic Mathematics Education (RME) approach in learning can make students actively involved. Active student involvement in learning is driven by the elements contained in the approach: students are required to understand contextual issues, explain contextual problems, solve contextual problems, compare answers, and conclude.

The learning process with Realistic Mathematics Education (RME) approach can help students develop students' mathematics communication skills. The development of students' mathematics communication skills can minimize the communication errors of mathematics when solving mathematics problems. Thus, the approach of Realistic Mathematics Education (RME) in learning is indicated to minimize the students' mathematics communication error in solving mathematics problems.

METHODS

This study included a type of literature study. The study of literature is the way used to collect data and sources related to the topics raised in a study. These data sources contain: Realistic Mathematics Education (RME) approach and mathematics communication errors. The sources are obtained from journals, books, articles, research reports and internet sites.

RESULTS AND DISCUSSIONS

Difficulties of students in learning mathematics seen from the error in solving mathematics problems. Error students in solving mathematics problems including one of the factors students have difficulty in learning mathematics. This is in line with Soedjadi's opinion, et al in Moma (2008: 24) says that difficulty is the cause of error. According to Budiyono in Wardi Syafmen, revealed that the forms of mistakes made by students in solving mathematics problems are concept errors, data use errors, data interpretation errors, technical errors and conclusion errors. The error occurs when students are given a contextual problem, when solving the problem they are unable to identify what is known, what is asked, and how to solve it. This happens because students do not have the skills to communicate in mathematics. One of them is the skills of mathematics communication that must be owned by students is the ability of students to convey ideas from a mathematics problem. According to NCTM in Zetriuslita (2013: 128), in the development of mathematics communication skills there are several indicators that must be achieved by students: the ability to express mathematics ideas through oral, written, and demonstrate and visualize it; the ability to understand, interpret, and evaluate mathematics ideas both orally and in other visual forms; and the ability to use terms, mathematics notations and structures to present ideas, illustrate the relationships of situational models.

The indicators of mathematics communication error can be obtained based on the form of errors in solving mathematics problems that are matched with indicators of students' mathematics communication skills. The student's mathematics communication error can be formed in several indicators, namely:

1. Concept Error
   Indicators: the error of determining mathematics ideas to answer the problem and the use of ideas by students is not in accordance with the conditions of the preconditions of the formula.
2. Using Data Error
   Indicators: do not use data that should be used in the form of drawings, diagrams, or tables, errors entering data into images, diagrams, or tables and adding unnecessary data to create images, diagrams, or tables.
3. Interpretation Data Error
   Indicators: errors in declaring ordinary language in mathematics language or mathematics symbols and errors in interpreting symbols, graphs, and tables, into math languages.
4. Technical Error
   Indicators: error calculation of solutions of problems using images, charts, tables, and algebraically, manipulation of ideas, situations, and declaring solutions of problems using images, diagrams, tables algebraically.
5. Conclusion Error
   Indicators: do the inferences without drawings, diagrams, correct supporting tables and do the inferences of statements that are not in accordance with logical mathematics ideas.

Based on indicators of mathematics communication errors above is expected to identify forms of mathematics communication errors students in solving mathematics problems. Mathematics communication errors can be minimized by maximizing students' mathematics communication skills. The skills of students' mathematics communication does not just come into existence by it self. This requires a process that helps students to become familiar with expressing mathematics ideas both orally and writing. The thinking process of students to find the right strategy in solving a problem. Therefore, the application of Realistic Mathematics Education (RME) approach in learning is considered to provide an opportunity for students to communicate in mathematics.

Lessons learned using Realistic Mathematics Education (RME) approach Treffer in Aryadi Wijaya (2011: 21) must meet the following characteristics: context usage, use of models for progressive mathematization, students' constructions, interactions and interrelationships. Besides the characteristics of Aryadi Wijaya (2011: 21) also reveals five main principles in Realistic Mathematics Education (RME) approach, which is dominated by contextual problems, attention is given to the development of models, situations, schemes and symbols, Of students, so students can make learning constructive and productive, meaning students produce their own and construct themselves (which may be algorithms, rules) so as to guide students from the level of informal mathematics to formal, interactive mathematics as a characteristic of the learning process of mathematics and 'Intertwinning' between the topics or between subjects or between 'strands'.

Each learning approach has a procedure or implementation steps that are structured according to their characteristics. The steps of applying the Realistic Mathematics Education (RME) approach in the lesson that Zukardi discusses in Ayesha

(2007: 20), the first thing done is to prepare the realistic problem; students are introduced to learning strategies that are used and introduced to realistic problems; then students are asked to solve the problem in their own way; students try different strategies to solve the problem according to their experience, can be done individually or in groups; then each student or group presented their work in front of the class, students or other groups responding to the work of the presenters; teachers observe the course of class discussions and provide feedback while directing students to get the best strategy and finding more general rules or principles; and after reaching agreement on the best strategy through class discussion, the students are drawn to the conclusion of the lesson at the time. In the end the students' learning must do the evaluation questions in the form of formal mathematics.

Based on the principles and characteristics of realistic based learning as well as taking into account the opinions that have been stated above, it can be compiled a step of learning mathematics with Realistic Mathematics Education (RME) approach, that is:

Step 1: Understand the contextual issues provided.

At this stage, students are given the opportunity to ask the unknown problem. Then, students use the contextual problem as a starting point in learning.

Step 2: Explain the contextual problem.

If in understanding the problem of students experiencing difficulties, then the teacher explains the situation and condition of the problem by providing clues or suggestions as necessary, limited to certain parts of the problem that has not been understood.

Step 3: Resolve the issue.

Students describe the contextual problem, interpret the existing mathematics aspects of the problem and think about the bulk-breaking strategy. Further solving the problem in its own way based on the initial knowledge it has, so that possible differences in the completion of students with each other. Teachers observe, motivate, and provide limited guidance, so that students can obtain solutions to these problems.

Step 4: Compare the answers.

The teacher asks the students to form groups in pairs with their on-board friends, working together to discuss solving individual-solved problems (negotiating, comparing, and discussing). Teachers observe the activities of the students, and provide assistance if needed.

Step 5: Conclude.

From the results of class discussions, teachers direct students to draw conclusions from a concept / principle formulation of the topics studied. Characteristics that appear in this step is the interaction between students with teachers.

The learning process using Realistic Mathematics Education (RME) approach is expected to maximize the mathematics communication skills that are possessed when solving a problem. Thus, the approach of Realistic Mathematics Education (RME) is expected to minimize students' mathematics communication errors in solving mathematics problems. The steps of learning mathematics with the approach of Realistic Mathematics Education (RME) is very appropriate to minimize students' mathematics communication errors when solving a problem. Compliance can be seen in the following table 1:

Table 1. Connection Steps of Realistic Mathematics Education (RME) Approach for Minimize Students Mathematics Communication Errors

No	Mathematics Communication Error Indicators	Steps of Realistic Mathematics Education (RME) Approach
1	Concept Error Indicators: the error of determining mathematics ideas to answer the problem and the use of ideas by students is not in accordance with the conditions of the preconditions of the formula.	Through the step of understanding the given contextual problems can minimize the mistakes of students' concepts in solving mathematics problems. This happens because students are accustomed to understanding the problem and determining mathematics ideas to answer the problem and the use of ideas by students so that according to the conditions of the prerequisites of the formula.
2	Using Data Error Indicators: do not use data that should be used in the form of drawings, diagrams, or tables, errors entering data into images, diagrams, or tables and adding unnecessary data to create images, diagrams, or tables.	Through the step of explaining the contextual problem can solve the errors of using student data in solving mathematics problems. This happens because students are accustomed to using only data that should be used and needed based on existing problems. Students use data that should be used in the form of drawings, diagrams, or tables, entering data into images, diagrams, or tables and don't adding unnecessary data to create images, diagrams, or tables.
3	Interpretation Data Error Indicators: errors in declaring ordinary language in mathematics language or mathematics symbols and errors in interpreting symbols, graphs, and tables, into mathematics languages.	Through the step of solving the problem can minimize the mistake of interpretation of student data in solving mathematics problems. This happens because students are accustomed to solving and declaring everyday language in mathematics languages or mathematics symbols and errors in interpreting symbols, graphs, and tables, into the language of mathematics.
4	Technical Error Indicators: error calculation of solutions of problems using images, charts, tables, and algebraically, manipulation of ideas, situations, and declaring solutions of problems using images, diagrams, tables algebraically.	Through the step of comparing the answer can minimize the technical errors of students in solving mathematics problems. This happens because students compare answers with other friends so students are able to analyze the calculations of problems using images, charts, tables, and algebraically, manipulating ideas, situations, and declaring solutions of problems using images, diagrams, tables algebraically.

No	Mathematics Communication Error Indicators	Steps of Realistic Mathematics Education (RME) Approach
5	Conclusion Error Indicators: do the inferences without drawings, diagrams, correct supporting tables and do the inferences of statements that are not in accordance with logical mathematics ideas.	Through concluding steps can minimize the conclusion errors of students in solving mathematics problems. This happens because students are accustomed to draw conclusions from the learning done so that students are able to do inferences with drawings, diagrams, tables supporting the correct and make inference statements in accordance with logical mathematics ideas.

Based on the above table, researchers believe that by applying the Realistic Mathematics Education (RME) approach in learning can minimize the mathematics communication error in solving mathematics problems. This is supported by Ahmad Fauzan (2002) study which states that teachers themselves recognize that there is a positive change in student behavior after they follow RME-based learning. Likewise with Yosmarniati, et al. (2012: 67) states that the application of learning with realistic mathematics education approach is effective to improve student learning outcomes in this case more focused on students' mathematics communication skills. Student activity in solving mathematics problems using PMR approach shows that students are able to present statement or problem in matter into mathematics language, explain the strategy of solving a mathematics problem, and present solution of math problem in detail and correct. Based on the above description and supported by relevant books, articles, research reports and internet sites, it is assumed that applying Realistic Mathematics Education (RME) approach in learning be able solve the mathematics communication error of students in solving mathematics problems.

CONCLUSIONS AND SUGGESTIONS

Mathematics communication error can be minimized by using Realistic Mathematics Education (RME) approach in learning. The steps of applying the Realistic Mathematics Education (RME) approach in learning are considered to provide an opportunity for students to communicate mathematics optimally. Optimal mathematics communication skills can minimize the mistakes students interpret information and convey ideas of a mathematics problem. This shows that the steps of Realistic Mathematics Education (RME) approach can be minimize the students' mathematics communication errors in solving mathematics problems.

Based on literature studies that have been done, the authors suggest:

1. To minimize the communication errors of mathematics students can use Realistic Mathematics Education (RME) approach as an alternative used in learning.
2. For the next writer to analyze students' mistakes in solving mathematics problems from various other mathematics skills that can be minimized by using Realistic Mathematics Education (RME) approach.

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IMPROVING THE ABILITY OF MATHEMATICAL PROBLEMS IN PARTICIPANTS USING APPROACHES REALISTICMATHEMATIC EDUCATION (RME)

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Abstract

The lack of a problem solving ability will affect the success of learning. This happens because the teaching is designed by a monotonous teacher on a single method of the lecture method so as to create an atmosphere of learning is dominated by teachers. In addition, it is very rare to confront students on the problems of life whose solution requires mathematics. As a result, the potential that is in the learners in mastering the concept of mathematics can not develop maximally so when given the problem of problem solving ability is not able to solve it. The solution is used as an alternative in the improvement of mathematical problem solving ability of students through the approach Realistic Mathematic Education. The RME approach is an approach that creates a learning mathematics rather than simply transferring mathematical concepts from teachers to learners, but learners themselves who reinvent the mathematical ideas and concepts through the exploration of real problems. The submission of contextual problems, learners are gradually guided to master mathematical concepts. Learners are also expected to use the power of reason to solve a problem presented. The research method used is research literature study that is by collecting various information about RME approach. After conducting literature studies citing data on the RME approach from various sources so it is suspected that the RME approach can improve students' mathematical solving abilities.

Keywords: RME *Approach,* Mathematical Problem Solving Ability.

PRELIMINARY

One of the problems in education in Indonesia is the weakness of the learning process (Sanjaya, 2007). Learning problems can not be separated from the ability of low-ability problem solving. Reality also shows that the problem solving ability of mathematics owned by learners in Indonesia at this time each classified as low. Based on the results of the TIMSS *(Trends International Mathematics Science Study)* 2015 note that Indonesia is ranked 45th of the 50 countries was limited to 2% at the *high* level, and 0% in the *advanced* level. While the results of the PISA survey in 2015 put Indonesia on the order of 63 of 69 countries in the field of mathematics.

From both the survey results and the studies that have been done by Wardani and Rumiati (2011:1) stated that one of the factors causing among others learners in Indonesia are generally not trained in solving problems with characteristics such as questions on TIMSS and PISA. Characteristics of these problems, requires learners to use reasoning, argumentation and creativity in solving the problem of test in the form of problem solving. This is in accordance with the report of Kemendiknas (Sindi, 2012: 7) We weak learners in doing the questions Which requires problem-solving, arguing and communicating abilities. Along with that, Arti Sriati (1994: 4), revealed that the mistakes of learners in doing math problems are as follows:

1. The concept's mistake is understanding Abstract ideas.
2. A Strategy error is an error happens if learners choose the path Which is not exactly pointing to Street Dead end.
3. The error count is an error Calculate mathematical operations.

Mistakes in solving math problems greatly affect the problem solving ability of learners. Furthermore, Sudiarta (2006) identifies the main factors causing the low ability of problem solving mathematics of learners, that is the learning that has been done so far has not been able to develop the ability of learners in matters of mathematical ideas appropriately.

Problem solvingshould be the central point of the mathematics curriculum and become an integral part of learning mathematics (Depdiknas, 2006).Therefore, required innovative approaches to the study of mathematics in solving problems *(problem solving).* Problem-solving strategies can guide learners in the learning process. Schommer-Aikins, Duell & Hutter (2005) points out *"In short, our results support the hypothesis that belief in quick / fixed learning may guide students in their choice of problem-solving strategies and the amount of time they spend on solving mathematical problems . "Learning* to approach problem-solving in essence using mathematical skills and knowledge of learners in solving mathematical problems which refers to Polya (1985), including understanding the problems, plan solutions, solve the problem according to plan, and check the results.

The low mathematics achievement of learners is caused by many factors, one of which is the learner factor that learners have problems comprehensively or partially in learning mathematics. In addition, learning mathematics of learners is also not meaningful so that understanding and understanding of learners about the concept of mathematics is still weak. One of the problems in learning mathematics in junior high school, among others, low ability of learners in solving mathematical problems are packed in the form of questions.

Most learners have difficulty in applying mathematical concepts in everyday life. They also revealed that mathematics is difficult, unattractive and less meaningful because mathematics is not related to real life but always there are formulas, numbers, variables that make them not really know what the use of the material is taught. This is due to the way teachers teach less involving learners in constructing new knowledge based on experience and very rarely confront the learners on the problems of life whose solution requires mathematics. In addition, learning designed by teachers is still conventional, teachers tend to use one-way teaching that only uses lecture methods that create an atmosphere of learning is dominated by teachers. Although in this learning learners can listen to statements that are pleased with the concept of mathematics, but there is an impression that the active is the teacher itself, while the learners only as a listener explanation of the teacher while recording the information provided. Such learning resulted in learners tend to memorize formulas and stages of mathematical problem solving. As a result, the potential that is in the learners in learning and mastering the concept of mathematics can not develop maximally so when given the problem with a slightly high level of ability / a different problem with the example of students unable to answer correctly and make learning math not yet running Effectively and not yet on target.

The role of educators (teachers) in the learning process is necessary for math learning feels good. Teachers play an important role in providing responsive development instructions to help learners gain the knowledge, skills and dispositions necessary for success (Bell & Pape, 2014). Teachers are required to determine the alternative of a learning approach that empowers learners so as to eliminate abstract impressions from math lessons and the impression not only memorize, but encourage learners to construct knowledge based on the discovery of their own learners. In addition, it should be able to bring learners on learning that refers to real life in their environment. To eliminate the abstract impression in mathematics learning, it must make learning more fun, active, and creative.

Based on the above, it is one of the alternatives that we believe can solve the problem is with the approach *Realistic Mathematic Education (RME).* Realistic mathematics education is a learning process in mathematics education were introduced and developed in the Netherlands in 1970 by the Freudenthal Institute. According to Freudenthal (Gravemaijer, 1994) mathematics is a human activity, so that learners should be given an opportunity to *reinvent* to the mathematical objects with the guidance of teachers. In RME, the process of developing mathematical concepts and ideas starts from the real world. The real world is by no means concrete physically and visually, but it also includes what the mind of a child can imagine (Hobri, 2008: 156). *RME* learning does not begin with the provision of the theorem / definition / formula, but asks students to find their own theorem / definition / of the formula. *RME* uses contextual problems as a starting point in learning mathematics.

Math classroom exploration is emphasized on the interrelation between mathematical concepts and the experience of everyday children. One of the mathematics learning that begins from the experience of everyday learners and applying mathematics in everyday life is realistic mathematics learning. This study is based on the concept of Freudenthal (1991) that mathematics must be connected with reality, to be close to the learner, relevant to the life of society, and the material must be transmitted as human activity. This means that mathematical materials should be the activities of learners and provide opportunities for learners to find math through practice that is done on their own and in accordance with the cognitive level of learners.

Learning with the RME approach begins with the use of phenomena and real application of the learners. The given problem is a contextual problem. In solving contextual problems, learners are guided constructively until they understand the mathematical concepts they learn, through the rediscovery of mathematical concepts and formulas. To achieve the objective of rediscovery of mathematical concepts and formulas, it is carried out with investigation activities and all learners will learn mathematics informally, and end with formal learning. Learning like this, will provide a positive value for the development of learners, especially in problem-solving activities. Discovery of the concept back through learning mathematics informally, learners will be faced with a variety of real problems, especially non-routine questions. This will train students' way of thinking in solving mathematical problems. So based on the above description it is assumed that the learning approach *Realistic Mathematic Education (RME)* can improve mathematical problem solving ability of students.

METHOD

This study included a type of literature study. With literature study is a way used to collect data and sources related to the topics raised in a study. The data sources containing: a mathematical problem solving ability, approach *Realistic Mathematic Education (RME).* The sources are obtained from journals, books, articles, research reports and internet sites.

RESULTS AND DISCUSSION

Problem solving is an integral part of mathematics learning, so it should not be released from the learning of mathematics. In line with that, NCTM (2000) states that problem solving has two functions in mathematics learning. First; Problem solving is an important tool to learn math. Many mathematical concepts can be effectively introduced to learners through problem solving. Second; Problem solving can equip learners with the knowledge and tools so that learners can formulate, approach, and solve problems.Therefore, effort in improving problem solving ability is very important for every teacher.

Furthermore, Mayer defines problem solving as a multiple step process with the problem solver having to find the connection between his past experience and the problem he is now facing and then act to solve it (Kirkley, 2003). Therefore, in problem-solving activities an approach is needed that is able to relate the life experiences of learners with new knowledge to be learned. This is particularly appropriate if the learning is applied learning by using approach *Realistic Mathematic Education.* According to Susanto (2014:205) RME is one of the learning approach of mathematics oriented to learners, that mathematics is human activity and math have to be connected significantly to context of everyday life of learners with experience of learning which oriented to things that real (real). Furthermore, According to Baker (1970) that the main principle of RME is that mathematics should always be meaningful to learners. The term 'realistic' stressed that the situation should issue *'experientially real'* for learners. This does not necessarily mean that the problem situation is always encountered in everyday life. Learners can experience abstract mathematical problems as real when the mathematics of the problem is meaningful to them.

Mathematical learning by using the RME approach will be oriented to real issues especially those related to the lives of learners. Such an approach will make it easier for learners to digest and understand every thing learned in mathematics. Because the example of the problem taken not far from his life. Such learning will transform the abstract mathematical property to a concrete or real thing. Not only that, through RME, mathematics learning will create a fun and meaningful because learners are not only demanded on the mastery of the concept alone but rather the ability to solve the problems of mathematics and the way of thinking in solving any mathematical problems.

Furthermore, in the RME, the mathematics is seen as a human activity *(human activity),* so that the learning activities carried out by using a real context and appreciate the ideas of learners in working on mathematical problems. Gravemeijer (1994), suggests three principles associated with *Realistic Mathematics Education (RME),* namely:

1. Guided reinvention and mathematical progressive. Guided discovery may also be inspired by informal settlement procedures. Then an informal strategy is useful to lead to more formal procedures. To support the process of obtaining various solution procedures, it is expected to follow the learning path through progressive mathematization process.
2. Didactical phenomenology. Situations in didactic phenomenology on mathematical topics are applied to investigate two things, namely uncovering the application part and completing progressive mathematization process.
3. Self-developed models. This principle is used to bridge the distinction between informal knowledge and formal mathematics.

The three principles above, are very appropriate in improving the problem solving skills of learners. Discovery of the concept of return demanded by teachers is needed in problem-solving activities. In solving the problem also, given the opportunity to learners in solving the problems of mathematics informally means that each learner is given the freedom to solve math problems in his own way. This is done to get a varied settlement. Furthermore, some of the solutions are considered following the mathematical procedure and serve as the final solution of the problem. It is also disclosed by Holmes (1995) that through problem solving learners are encouraged to explore, take risks (with assumptions and strategies selected), share success stories and failures (in obtaining the settlement), and mutual questioning strategies and results obtained Another learner.

Furthermore, according to Freudenthal (in Gravemeijer, 1994), RME also has five characteristics, namely:

6. Using contextual problems*;* Learning begins with contextual issues to enable learners to use previous experience and knowledge of its beginning directly, starting from the formal system.
7. Using vertical instruments such as models, schematics, diagrams, and symbols*;* This means that learners make their own models in solving contextual problems which is the relationship between real-world situational models that are relevant to the environment of learners into the mathematical model.
8. Using the contribution of learners*;* A great contribution in the learning process is expected to come from the learner, not the teacher. This means that all the thoughts or opinions of learners are noticed or appreciated.
9. Interactive learning process*;* Interaction forms such as negotiation, explanation, justification, approval, question, or reflection are used to achieve the informal mathematical knowledge form that the learners find themselves.
10. Related to other topics*;* In RME the integration of mathematics learning units is essential (essential). By integrating it will make it easier for learners to solve the problem.

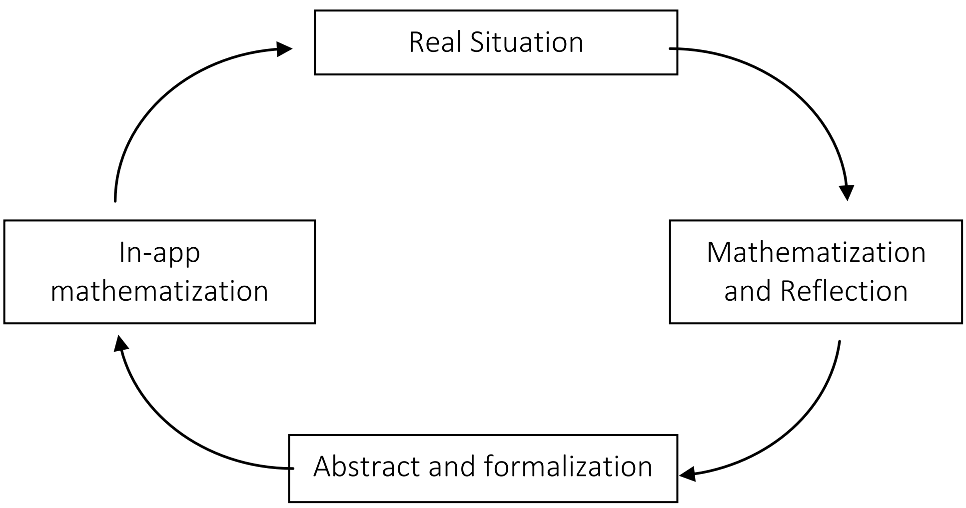
The five characteristics of the RME approach have conformity to the problem solving indicator. According to NCTM (1989:209) indicators of problem-solving skills in learning mathematics are:

1. Formulate the problem
   The RME approach uses contextual issues. In formulating the problem on learning RME does not start from the formal system but the issues raised must be in

accordance with the reality or environment of life faced by learners in their daily life that is understood and easy to imagine.

2. Use various strategies to solve problems
   In the RME approach, the strategy used in solving mathematical problems, namely through vertical instruments such as model schemes, diagrams, and symbols. The strategy is used by learners as a bridge to understanding his new knowledge related to his real life.
3. Solve the problem
   To solve mathematical problems in learning RME is given the widest opportunity to learners to construct their own knowledge through vertical instruments in solving mathematical problems encountered.
4. Check and interpret results
   This section corresponds to RME characteristics that require the interaction of learners with teachers and learners with other learners. Interactions such as negotiation, justification of approval, question, or reflection are used to achieve an informal mathematical knowledge form that the learners find themselves. Teachers should provide opportunities for learners to communicate their ideas through interactive learning.
5. Generalize the solution
   In RME learning, after reaching agreement on the best solution through class discussion, learners are invited to generalize the solution as a conclusion of the solution of mathematical problems encountered.

Based on the above table, then the description of mathematics learning by using the RME approach to improve the problem solving ability of mathematical learners can be described in a diagram as follows:



(De Lange, 1987: 72)

Based on the above, so the researchers believe the approach *Realitic Mathematic Education (RME)* in mathematics can improve mathematical problem solving ability of students. This is also supported by the results of research conducted by Syaiful (2012) in his research concluded that learning using RME approach, can improve the ability of problem solving math. Aktvitas learners in solving the problem of problem solving skills of mathematics shows that learners who get the learning with PMR approach is better than the learners who received learning with PMB. The responses and attitudes of learners towards learning using the PMR approach are very positive. Followed by the results of the study by Nila Kesumawati (2009) revealed that the improvement of mathematical problem-solving ability of learners who received learning with PMR Approach better than learners who received learning with a conventional approach when viewed from each school ranking and the combination. Through the PMR approach is able to grow the atmosphere of the class become more dynamic, democratic and cause a sense of fun in learning mathematics.

It has also been investigated by earlier researchers Fauzan (2002), Armanto (2002), Lubis (2016), Kwon, et. Al (2013), Stephan & Cobb (2013), Rangkuti (2015), Yulinasari (2016), and Sary (2016). Based on the results of relevant studies so that researchers believe the approach *Mathematic Realitic Education (RME)* in the learning of mathematics will improve mathematical problem solving ability of students. Based on the above and is supported by some relevant previous researchers then estimated by applying the learning approach *Realistic Mathematic Education (RME)* can enhance problem solving abilities.

CONCLUSIONS AND SUGGESTIONS

Approach *Realistic Mathematic Education (RME)* can enhance the problem solving mathematical learners due to the approach *Realistic Mathematic Education* (RME) is an approach that puts the reality and experience of the learner as a starting point of learning in which learners are given the opportunity to construct their own knowledge of mathematics formally through problems -the realities of reality. The realistic problems that are given during the learning process give a descriptive influence to the learners so that learners can solve problems from understanding the problem, designing problem solving strategies, performing calculations and re-examining the results given.

Based on literature studies that have been done, the authors suggest:

1. To improve mathematical problem solving ability of students, teachers can use the approach *Realistic Mathematic Education (RME)* as one of the alternatives that are used in mathematics.
2. It is expected to analyze more deeply on the problem-solving indicators of the RME approach.
3. For the author, the next in order to examine more knowledgeable about the approach *Realistic Mathematic Education (RME)* in enhancing the ability to think mathematically more apart from the problem-solving ability.

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THE EFFECT OF SCIENTIFIC APPROACH AND PRIOR KNOWLEDGE TO MATHEMATICAL CRITICAL THINKING ABILITIES STUDENTS' IN JUNIOR HIGH SCHOOL AT SMPN 8 PADANG

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Abstract

This study investigated the effect of scientific approach and entry behavior to the mathematical critical thinking abilities student' in junior high school at SMPN 8 Padang. The population is all students who study at SMPN 8 Padang level as high as grade class VIII. The sample in this study is randomly selected from the study population numbering 64 people in two groups .The research is held in August 2016 semester of the school year 2016/2017. The method used is quasi experimental with 2 x 2 design by level. Sixty four students were assigned randomly into instruction with scientific approach group and directed instructional group. The two groups exposed were expected to have a high and low score in entry behavior for mathematical critical thinking abilities. However, there was significant effect was found between the mean posttest scores of the scientific approach and directed instructional in the mathematical critical thinking abilities. The result of the research were : 1) mathematical critical thinking abilities student' with scientific approach was better than direct instructional, 2) there was an interaction between scientific approach and prior kwowledge to mathematical critical thinking abilities student', 3) mathematical critical thinking abilities from students with high entry behavior and scientific approach was better than direct instructional, 4) mathematical critical thinking abilities from student with low entry behavior and scientific approach was no different than direct instructional.

Keywords: *Scientific approach, entry behavior, mathematical critical thinking abilities*

INTRODUCTION

The quality of the results of student learning in the mathematics lesson is an indication that the specified learning goals achieved in accordance with the expectations. hope to be achieved is the selection and use of your mathematics teaching that right. Teachers must be able to select the approach to learning and teaching materials is the right time because the approach to learning and teaching materials that right on being alone is one of the efforts in optimizing the results of student learning.

The reality on the ground is different from the one expected from the results of the observations made on the Mathematics lessons at SMP 8 Padang, seen during the learning process is still not optimal. The learning process that happens in the school information focused on teachers. Started learning from the teachers to explain the subjects information provide examples of questions and at the end of the lesson provide exercise to the students. The questions given to the students is usually in the form of the questions that are routinely, so having difficulty completing the questions vary which require critical thinking. Learning that makes the students less active and does not independently and always waiting for an answer from the teacher so that the students only receive and less well trained in build knowledge itself in solving the questions of mathematics presented in the subjects. Therefore, mathematics teaching activities such as this does not show the ability to think critically students so that the students learning less satisfactory results. This is seen when doing observation, where given 2 fruit questions test the ability to think critically to 63 students in 2 classes VIII SMPN 8 Field which contains the indicator critical thinking mathematically namely identify, draw conclusions and evaluate. The results of these observations indicate that the ability to think critically students still low handles as shown in table 1 below:

Table 1. The results of the test the ability to think critically mathematically
The students of class VIII SMP 8 Padang

The question of no	The indicator	The Number of Students				The Average Scores
		Score 0	Score 1	Score 2	Score 3	
1	A. Collect and arrange the required information	3	37	17	6	1.4
	B. Evaluate the statement	7	28	26	2	1.3
	C. Draw conclusions	11	23	29	-	1.3
	D. Test the conclusion	17	27	13	6	1.1
2	A. Evaluate the statement	5	37	18	3	1.3
	B. Collect and arrange the required information	6	19	36	2	1.5
	C. Draw conclusions	5	34	20	4	1.4
	D. Test the conclusion	9	39	12	3	1.1

Based on the table 1 seen that the average scores of the test results show is still a little percentage number of students achieve maximum score of 3. This shows that the ability to think critically mathematics students who represented by the four indicators are not optimal. The average score of the ability to think critically is obtained on the two questions is to collect indicator and arrange the required information with the average 1.5 score, evaluate the statement 1.3, draw conclusions 1.4, and test the conclusion obtained 1.1. This shows that the ability to think critically mathematics is represented by the four indicators are not optimal.

One of the weakness of the learning process is conducted until this time is less than the effort to raise the ability to think critically students. Each of the process of learning mathematics more encouraging students over a number of the subjects. Learning is done is abstract and theoretically obtained through exercises so that the students knowledge built over the process of the habit. This causes the students did not get the opportunity to improve their ability to think improves that ultimately students memorise only all the concept without understanding the interpretation.

In addition, seen from the learning process used teachers still dominant uses learning. In this learning, teachers is seen as a source of knowledge and the students only need to accept that knowledge without must be actively involved in the learning process maximum in class. This impact on the low ability to think mathematically students as explained above. According to Polla (2001: 48) "mathematics education in Indonesia, seems to need the reformation especially in terms of the learning activities. This time so many students complain and assume that mathematics is very difficult and is a scourge, as a result they did not enjoyed even hate on math. If there needs to be a movement to make a fundamental change in mathematics education, especially from learning strategies and its approach". This means, need to reform in mathematics teaching approach from usually centralized activity on teachers to the situation that made the center of attention is the students. The teacher as a facilitator and mentor while students as that led not only copy the following examples without understanding the concept of mathematical prowess.

The main principles of mathematics teaching is to improve and prepare the students to learn the useful for students and aims to switch from the paradigm of teaching mathematics to learn mathematics, the relevance of the students actively in learning must be supported by the organised learning activities that specifically so that the students can perform "*doing math"* to find and build mathematics with facilitated by teachers.

One of the approaches that were supposed to be able to resolve the problem is the scientific approach. The scientific approach is an approach in mathematics teaching respect of mathematics as a human activity. The apparel scientific approach dimension composition observation, logic, discovery and the explanation of a truth where the learning process must be guided by the values, principles, or scientific criteria. The scientific approach to load the steps 5M namely observing, ensnared, try, associate and communicate (Kemendikbud, 2013: 10). To support the scientific approach, it is important to note some of the things that the prior to knowledge of mathematics (PKM) students, and the problems faced in the students. Teachers should also be able to collect and identify the PKM is owned by the students before starting the lesson. Prior to knowledge of mathematics as early competence should have mastered the students before a series of mathematics teaching next. Knowledge beginning this is a preliminary readiness of students in receiving learning that will be delivered and is part of the integrated from the new learning. This is done because of the relevance and connectedness between the PKM that is owned by the subjects that will be studied.

In order to get the ability to think critically mathematical good then PKM students must also be good. PKM is owned by the students can be known when has done measurement and assessment on students before the lesson. This can be deduced that the early ability have two characteristics, namely : (1) as a precondition for learning to face the next lesson, and (2) has a relationship with the results of learning mathematics in the materials and tasks mathematics teaching next.

On the scientific approach suspected that more benefit is that the students in the PKM and low. This is because the steps scientific approach based on the development of creativity and learning theories that involve cognitive processes and affective, and can grow the jealousy of learning and the potential of the creative potential. As known that generally in mathematics teaching that to the attention of the teachers is that the students who have high ability, while the students with the ability to PKM is low and that generally in class rank is low and less gain attention. Therefore, scientific approach is suspected to accomodate the desire of all students to show the potential capabilities that he possessed.

Meanwhile for the students who are on high rank class through scientific approach also will develop the ability to think critically mathematically. But the development of the ability is allegedly not because the factors learning approach but because of factors students who already versed. Pay attention to the explanation above, in general can be said that the scientific approach with attention to the early knowledge of mathematics is expected to improve the ability to think critically mathematical students. Based on the explanation above then the problem formulated as follows; The main problem in this research is how junior high school students' critical thinking ability on mathematics based on scientific approach and students' entry behavior?

THEORETICAL FRAMEWORK

Critically Mathematically Think Ability

Learning is a process that based on the activity of thinking. The person in the activity of thinking shows the level of the ability to think. The activities of thinking students will occur when the students have to be aware that certain material is not easy, students must know the material, compare what he saw and always see and analyze the material from a variety of a different perspective.

Ennis revealed that critical thinking is thinking that reasonable and reflective focusing to decide what must be trusted or done. In receiving an information that can be trusted a person must be able to think critically to know the truth from the information received Ennis mentioned that critical thinking includes two things namely dispositions critical thinking *critical thinking dispositions* and the ability to think critically (*critical thinking abilities*). More clearly Vieira mentions " *abilities refer to the more cognitively intact and disposition aspects to the more affective*". (*Abilities ability*) more refers to the cognitive aspects, while dispositions (*dispositions*) more refers to the affective aspects.

Based on this it can be concluded the ability to think critically started to resolve the issue with a specific purpose and then analyze, generalize, organize ideas based on the existing information and deals give the conclusion in solving problems on a systematic basis with the correct arguments. According to Richard W. Paul, critical thinking is the process of discipline intellectually where someone is actively and skillfully understand, applying, analyzing, synthesize and evaluate the various information that he or she take from the experience, observation, reflection which he did, logic or the communication that he did. So someone who think critically will always active in understand and analyze all the information he found.

Rudnik Krulik and proposed that that including critical thinking in mathematics is thought that test, questioned, connect, and evaluating all aspects of that is in a situation or a problem. Critical thinking allows students to find the truth in the midst of a massive influx of Genesis and the information that surrounds them every day. Critical thinking is a systematic process that allows students to formulate and evaluate beliefs and their own opinions.

Critical thinking in Learning Mathematics is a process of cognitive or mental actions in an effort to acquire knowledge of mathematics based on the logic of mathematics. Based on the explanation of the explanation that has been advanced formulated the sense of the ability to think critically mathematics is the ability to think critically begin with solving problems with a particular purpose and then analyze, generalize, organize ideas based on the existing information and deals give the conclusion in solving problems on a systematic basis with the correct arguments.

The other opinion related to the ability to think critically indicator including, *interpretation, analysis, evaluation,* and *inference.* In this research will use the indicator the ability to think critically is supported by the results of the research that has been measuring the ability to think critically students in solving mathematics problems using the ability to think critically indicator developed by Facione

1. *The Scientific approach*

The scientific approach is learning that adopted the steps scientists in building knowledge through scientific method. This learning encourage the students to better able to apply the steps 5M namely observing, ensnared, try, asosiasi and mengomu-nikasikan (Depdikbud, 2013:9). Each step is explained as follows.

1) Observe

Observe the preference method learning process (*meaningfull learning*). In the activity of observing teachers open widely and vary the opportunity to the students to make observations through the activities: see, catching, heard and read. Teachers facilitate students to make observations, train them to note (see, read, hearing the important thing from an object or objects.

Observing activities with the aim of learning is closely related to the context of the real situation faced in life. The process of observing the fact or phenomena include finding information, see, hear, read and/ or catching (Depdikbud, 2013:9). The students are given a phenomenon or fact, and the students were asked to observe the phenomenon or the facts presented. The activities observed make students feel challenged and arise curiosity about the materials to be learned.

2) Mutual Inquiry

After the students observe the fact or phenomenon that is given, then teachers encourage and direct the students to make up questions based on the fact or phenomenon that is observed. If the students have not been able to give the question then the teachers can be fishing for students with questions that encourage students to think and draw up a question.

Ensnared activities done as one of the process of building the knowledge of the students in the form of the concept, principles, procedures of the law and the theory, to think metakognitif. The aim is that the students have the ability to think high level (*critical thinking skill*) critically, logical and systematic. (Depdikbud, 2013:9). The activities done by the students accompanied by ensnared guidance teachers is expected to encourage them to build their own knowledge in the form of the concept, principles, procedures of the law and the theory. The process of mutual inquiry can be done through activities such as discussion and group work and class discussions. The practice of group discussions provide room freedom of expressing their ideas/ ideas with their own language.

3) Gather information or experimenting/try

After the students are able to draw up the question the next step is to encourage the students to answer their own questions. This activity is trying to stage. Try activities aimed to strengthen the understanding of the concept of the principles or the existing procedure in learning materials. A good learning is learning which directs the students to try to own find the concept, the principles and procedures so that they can train to develop the ability to think and to strengthen their understanding of the material studied.

4) Associate/processing information

After the students are trying to with how to collect data and data processing next students analyzing data that has been processed and make the conclusion. Mengasosiasi activities demanding students create own conclusions from the concept of the principles and procedures that are on the subjects that are being studied. This mengasosiasi activities also train the logic and critical thinking students in analyzing the answers from the problems and given question /make the conclusion from the answers.

5) Communicate

The next activity is to write or tell what is found in the activities of the search for information, associate and find the pattern. The results were presented in class and assessed by the teacher as a result of student learning or student groups. In teaching students not only required how can understand the matter and solve the problems given but students also must be able to communicate ideas/ ideas or answers that they have both orally and in writing.

Prior to Knowledge Mathematics

Prior to Knowledge Mathematics (PKM) is the knowledge of mathematics students before conducted learning. The knowledge of mathematics is covers the matter of school mathematics is the ability to start to learn about the matter of mathematics next. Reigeluth explains the ability of the beginning is all the competencies on the bottom level (sub tasks) that should have been mastered before students begin a special learning demolishes absolutely immigrant to working competency in the ability of the early. According to Cecco, early capability is the knowledge and skills that has been owned by the students before he advance to the next level. Therefore the ability of the beginning of an important part of cognitive ability next. Students who have knowledge of the early conditional have the possibility to follow and implement the next learning tasks.

In learning mathematics in schools, PKM owned school students consists of knowledge of the various units of the adjacent mathematics study the important matter as numbers, geometry and algebra that has learned, if seen from the multitude of units of the adjacent each of the mathematics study the important matter that has studied the students from primary school, appear that the early knowledge of mathematics is very much and very varied but if seen from the conception of mathematics as a system, then PKM to every important matter of study can be grouped into the :

a) The initial knowledge about the association of the object of mathematics,
b) The initial knowledge about the relationships between objects the association of mathematics, and
c) The initial knowledge about the operations that can be done between objects - the object of the association of mathematics.

Objects or elements of the association of mathematics such as specific numbers, letters, and various other algebra forms can be found on every system of mathematics. Types of relationships as well as similarities, and operations such as addition and multiplication, can be found on every system of mathematics. Based on the explanation above can be stated that the association, relations, and the basic operation this is the first important knowledge in learning mathematics schools. The initial knowledge to work as a knowledge of the prerequisites that have a very important role in determining the readiness of student learning.

There are various opinions from experts about understanding pengetahunan, i.e. as follows: Jonasen and Gabrowski stated that the initial knowledge is the knowledge, skills or capabilities that brought students into the learning process. Dochy research in Tri Dyah Prastiti about knowledge beginning to find that the knowledge of the beginning students contributed significantly to the score leaderboard post-test or learning gains. Based on the above opinions, it can be concluded the initial knowledge is a combination of the attitude, experience, skills and knowledge that belongs to the students as capital in the learning activities that have a significant contribution to the earnings results (achievements) learn. The experience and skills that belong to the students is obtained before the students do the learning process at that time.

Teachers should be able to collect and identify the PKM is owned by the students before starting the lesson.PKM of mathematics as early competence should have mastered the students before a series of mathematics teaching next. Knowledge beginning this is a preliminary readiness of students in receiving learning that will be delivered and is part of the integrated from the new learning.

To determine the knowledge level of the beginning of mathematics students need to be done before measurements learning process. The effort to the measurement of the PKM can be done with the test both orally and in writing. The use of the PKM test can be used to find out whether the students have the appropriate knowledge or not. The results obtained from the PKM test can be used as a prerequisite to follow the activities of learning mathematics. This is done because of the relevance and connectedness between the PKM that is owned by the subjects that will be studied.

In order to get the ability to think critically mathematical good then PKM students must also be good. PKM is owned by the students can be known when has done measurement and assessment on students before the lesson. This can be deduced that the early ability have two characteristics, namely : (1) as a precondition for learning to face the next lesson, and (2) has a relationship with the results of the study in the materials and learning tasks next.

METHOD

This research is experimental research. The method used is quasi experimental. The population is all students who study at SMPN 8 The U.S. level high u.s. grade class VIII The sample in this study is randomly selected from the study population numbering 64 people in two groups VIIIA and VIIIB. It is selected do we stop? Because it has low scores . Sixty four students were assigned randomly into instruction with scientific approach group and directed instructional group. The two groups were exposed was much bigger to have a high and low score in entry behavior for mathematical critical thinking abilities. The instruments used in this study include mathematics test, test of mathematical skills in critical thinking and the PKM of students' test. The data analysis in hypothesis testing used t-test.

This research quasi-experiment because researchers do the giving of the treatment to the subject of research for the next want to know the influence of the treatment. The treatment is a scientific approach to learning in the classroom experiments and learning directly on the control class class. Free variables in this research is a scientific approach to learning and teaching directly. The class is taught with scientific approach is the class experiment, while the class is taught by learning directly is the control classes. This is done to know more deeply the influence of the scientific approach and knowledge of the PKM students to the ability to think critically mathematical students. The design of the experiment that is used is a *non-equivalen posttest-only control group design* that merged with the design 2 x 2 namely, two groups PKM students (high and low), and two approaches (Scientific and directly).

The population of this research is that the students SMP 8 field. Affordable population is the students of class VIII who follow the process of mathematics teaching in the second semester odd years 2016/2017 lessons. The sampling is done with the technique of *multi stage random sampling* with steps as follows: (1) select random from 8 class VIII SMP 8 Padang, (2) select random two classes of a class that is not a superior class to be the class of treatment this research, (3) select random where the class experiment and control classes given the test to know the knowledge of early mathematics high and low scores from the test and then rated from the highest score and lowest, then taken as much as 27 percent of groups as a group of early knowledge of mathematics high and 27% lower group as a group of early knowledge of mathematics low. To collect data in this research used two test technique , namely the test consists of a set of questions to measure and know the early knowledge of mathematics students, test the ability to think critically mathematically. Test techniques in collecting data using two kinds of instruments made by the researchers namely (1) test the ability to think critically mathematical, (2) test the initial knowledge of mathematics students.

Quantitative data analysis techniques performed for each candidate data groups in accordance with its problems. Quantitative data processing is done through two main stages.

3. The first stage: test statistics requirements needed as the basis in the hypothesis testing, namely normalitas test the spread of the data and test the homogenitas varians.
4. The second stage: test whether or not the difference from each of the groups and the influence of the interaction of the ability to think critically mathematical knowledge of the beginning of mathematics in accordance with the hypothesis that has been put forward

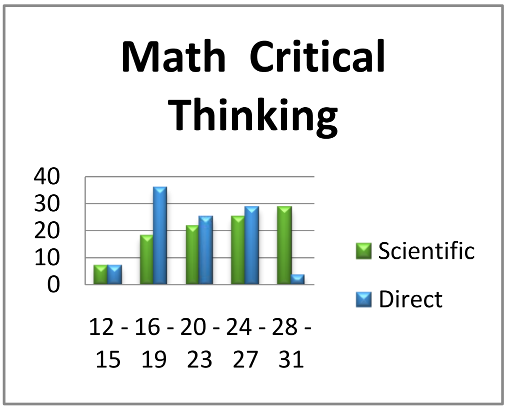
RESULT AND DISCUSSION

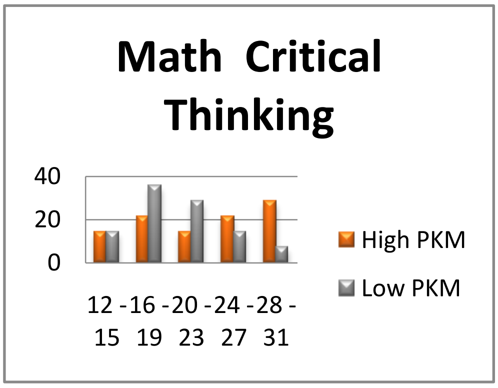
Prior to Knowledge of mathematics (PKM) students is the knowledge that belongs to the students before the learning process takes place. Early knowledge of mathematics is the value of the test the ability of mathematics students in the first semester I and II in class VII SMP.

To know the equality of the sample research done statistical analysis test the difference between the average scores of the early knowledge of mathematics. Prior to test the difference between the average, first test done and homogenitas normalitas varians data, and get the conclusion that the sample comes from a population of berdistribusi normal. From the analysis of the data obtained that there was no significant difference between the PKM students who obtain scientific approaches to learning and the students who get direct learning.

The ability to think critically Mathematical Students

The results of the test Data the ability to think critically mathematically described and analyzed based on scientific approach and knowledge of PKM students. Comparison of the ability to think critically mathematically based on the PKM students can be seen in figure 1. From the picture 1 seen that based on the PKM students, the ability to think critically students who get PS learning is still better than the students who obtain lesson DL.





In the figure above an average of the ability to think critically Mathematically based on the PKM. Based on the hypothesis 1, after done the calculation and analysis about homogenitas normalitas, it can be concluded that there is a significant difference in the ability to think critically mathematically between the students who get PS learning and the students who get the DL learning means that the ability to think critically mathematical students who get PS lessons better than the ability to think critically mathematical students who are taught in DL.

From the hypothesis 2, after data homogenitas test the ability to think critically based on the PKM students, then seen whether there is a difference between critical ability mathematically based on the PKM students through t test. From the test results can be concluded that there is a significant difference in the ability to think critically mathematical students when based on the PKM students.

On the hypothesis 3, first seen homogenitas varians capability data critical thinking mathematically as a result of the interaction between the PKM students and saintific approach . From the results of the test calculations obtained statistics conclusion that PKM students give a significant impact against the difference between the ability to think critically mathematical students. So the scientific approach to give a significant impact on the ability to think critically mathematically.

From the value of F and the value of sig concluded there was no interaction between PKM students with scientific approach to the ability to think critically mathematically. In other words the students who get scientific approach learning seen from PKM students get a better value in the ability to think critically mathematically compared with students who have learning PL on each category PKM.

CONCLUSION

1. There is a significant difference in the ability to think critically mathematically between the students who get PS learning and the students who get scientific

approach lessons better than the ability to think critically mathematical students who are taught in direct learning.

2. There is a significant difference in the ability to think critically mathematical students when based on the PKM students.
3. Scientific approach to give a significant impact on the ability to think critically mathematically.

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PRIME IDEALS IN *B*-ALGEBRAS

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Abstract

B-algebra is a subclass of K-algebra, which is constructed of a noncommutative group. So that, we find the concept of B-algebra by the properties of the group. If there is a subgroup in the group, hence there is B-subalgebra in the B-algebra. In this paper, we constructed the concept of prime ideals in B-algebras based on the concept of prime ideals in BCI and BCK-algebras.The result are definingan ideal in B-algebra and a prime ideal in B-algebra. Also, we discussed some of it's properties. Then, we have proved several theorems about the relationship between a prime ideal and a maximal ideal in B-algebra.

Keywords: *B-algebras, B-subalgebras, ideal, prime ideal*

INTRODUCTION

A group is a non-empty set with a binary operation such that the following properties hold:associative law, existence of an identity element, and existence of an inverse [2]. While, a ring is a non-empty set with two binary operations of sum and multiplication, such that the following properties hold: assosiative law of multiplication, distributive law, and a ring is a commutative group of addition operation [2]. Group and ring are algebraic structures that often discussed by several authors.

The new algebras are found in the development of abstract algebra. In 1996, Y. Imai and K. Iseki introduced the development of the algebraic structure called *BCK*-algebra. In the same year, K. Iseki introduced the new idea called *BCI*-algebra, that is generalization from *BCK*-algebra. In 2002, J. Neggers and H. S. Kim constructed a new algebraic structure. They took some properties from *BCI* and *BCK*-algebra be called *B*-algebra. A non-empty set X with a binary operation $*$ and a constant 0 satisfying some axioms will construct an algebraic structure called *B*-algebra.

The concepts of *B*-algebra have been disscussed, e.g., *a note on normal subalgebras in B-algebras* by A. Walendziak in 2005, *Direct Product of B- algebras* by Lingcong and Endam in 2016, and *Lagrange's Theorem for B-algebras* by JS. Bantug in 2017. Earlier, in 2010, N. O. Al-Shehrie applied the notionof left-right derivation in *BCI*-algebra [10] to *B*-algebra and obtained some related properties [7]. Then, in 2012, notion of prime ideal was introduced by R.A. Borzooei and O. Zahiri in the article entitled "*Prime Ideals in BCI and BCK-algebras*".They found a new definition of prime ideal in *BCI*-algebra and some of its properties. In this article, we apply the concept of prime ideals in *BCI*-algebra to *B*-algebra and we attempt to apply some its properties to *B*-algebra. So, this article discuss about the definition of prime ideal in *B*-algebra, and we investigate some of its properties.

METHOD AND DESIGN

This research is literature study by studying the text books and journals related to the prime ideals in ring, prime ideals in *BCI* and *BCK*–algebras, and the concepts of *B*-algebra. The methods used in this research are as mention below:

1. Study the concept of *B*-algebra and its properties introduced by J. Neggers and H. S. Kim.
2. Study the condition of a subset is a *B*-subalgebra.
3. Construct the concept of ideal in *B*-algebra based on the concept of ideal in *BCI* and *BCK*-algebra that discussed by Borzooei and O. Zahiri.
4. Investigate the condition an ideal in *B*-algebra that is: let *S* a non-empty subset of *B*-algebra $(X; *, 0)$ with a constant 0 and *b* element of *S.* If *b* is operated with *a* from the right and the result is also an element of *S*, hence *a* also element of *S*.
5. Investigate the prime ideal in *B*-algebra $(X; *, 0)$ by taking a proper subset of *X* and constructed based on the concept of prime ideal in *BCI*-algebra.
6. Prove some related theorems.

I. *BCI*, *BCK*, and *B*-Algebras

The related definition to *B*-algebra, *BCI* and *BCK*-algebras will be discussed in the beginning of the study.

Definition3.1. [4] A *B*-algebra is a non-empty set X with a constant 0 as identity element and a binary operation $*$satisfying the following axioms:

I. $x * x = 0$,
II. $x * 0 = x$,
III. $(x * y) * z = x * \big(z * (0 * y)\big)$,

for all $x, y, z \in X$.

Example 3.1.[4] Let $X = \{0, 1, 2\}$ be a set with Cayley table as follows:

Table 1

*	0	1	2
0	0	2	1
1	1	0	2
2	2	1	0

As known $0 \in X$and $1, 2 \in X$, it can be seen from the Table 1 that is $2 * 0 = 0$, $2 * 2 = 0$ and $(1 * 2) * 0 = 1 * \big(0 * (0 * 2)\big) = 2$ satisfying the three axioms *B*-algebra. Then,$(X; * ,0)$ is *B*-algebra.

Theorem 3.2 [4] Let$(X; * ,0)$ is *B*-algebra,then for all $x, y, z \in X$,

I. $y * z = y * \big(0 * (0 * z)\big)$,
II. $(x * y) * (0 * y) = x$,
III. if $x * z = y * z$ implies $x = y$,
IV. $x * (y * z) = \big(x * (0 * z)\big) * y$.

Proof.

I. For all $y, z \in X$, using axiom II and III *B*-algebra we obtain:
$y * z = (y * z) * 0$ (by axiom II)
$y * z = y * (0 * (0 * z))$. ■ (by axiom III)

II. For all $x, y, z \in X$, let $z = 0 * y$, using axiom I, II, and III we obtain:

$(x*y)*(0*y) = x*((0*y)*(0*y))$ (by axiom III)
$(x*y)*(0*y) = x*0$ (by axiom I)
$(x*y)*(0*y) = x.$ ■ (by axiom II)

III. For all $x, y, z \in X$, since $x*z = y*z$, implies $(x*z)*(0*z) = (y*z)*(0*z)$ and thus from II it follows that $x = y$. ■

IV. For all $x, y, z \in X$, from I and axiom II:
$\big(x*(0*z)\big)*y = x*\Big(y*\big(0*(0*z)\big)\Big)$, then
$\big(x*(0*z)\big)*y = x*(y*z)$.■

Theorem3.3 [4] If$(X;*,0)$ is B-algebra, then the following conditions hold: for all $x, y, z \in X$,

I. $x*y = 0$ implies $x = y$,
II. $0*x = 0*y$ implies x=y,
III. $0*(0*x) = x$.

Proof.

I. For all $x, y \in X$, since $x*y = 0$, implies $x*y = y*y$, by applying Theorem 3.2 (III) then $x = y$.■

II. For all $x, y \in X$, using axioms of B-algebra, we obtain:
$0 = x*x$ (by axiom I)
$0 = (x*x)*0$ (by axiom II)
$0 = x*(0*(0*x))$ (by axiom III)
since $0*x = 0*y$, then
$0 = x*\big(0*(0*y)\big)$
$0 = (x*y)*0$ (by axiom III)
$0 = x*y$ (by axiom II)
$x = y$.■ (by axiom I)

Definition 3. 4. [11] A nonempty subset S of B-algebra X is called a subalgebra (B-subalgebra) of X if $0 \in S$and$a*b \in S$ for all $a, b \in S$.

Example 3.2. Let $X = \{0,1,2,3,4,5\}$.Define the binary operation "$*$" on X by the following table:

Table 2

*	0	1	2	3	4	5
0	0	2	1	3	4	5
1	1	0	2	4	5	3
2	2	1	0	5	3	4
3	3	4	5	0	2	1
4	4	5	3	1	0	2
5	5	3	4	2	1	0

It is easy to prove that $(X; *, 0)$ is a B-algebra. Let$S = \{0,1,2\}$, we have $0 \in S, 1, 2 \in S$, and based on the Table 2 that is $1*2 = 2 \in S$. Then S closed to binary operation $*$, hence S is B-subalgebra.

Definition 3.5. [9] A B-algebra$(X; *, 0)$ is said to be *commutative$B$-algebra* if $a*(0*b) = b*(0*a)$, for any $a, b \in X$.

Example 3.3. Let $X = \{0, 1, 2\}$ be a set with the following table:

Table 3

$*$	0	1	2
0	0	2	1
1	1	0	2
2	2	1	0

It is easy to prove that $(X; *, 0)$ is a B-algebra. We have $0,\ 1,\ 2 \in S$, and based on the Table 3 that is $1 * (0 * 2) = 2 * (0 * 1) = 0$. Then $(X; *, 0)$ is a *commutative* B-algebra.

Teorema 3.6. [4] If$(X; *, 0)$ is a *commutative* B-algebra, then

I. $(0 * x) * (0 * y) = y * x$,
II. $x * (x * y) = y$,
III. $(0 * x) * (x * y) = y * x^2$,

for any $x, y \in X$.

Teorema 3.7. [13] Let$X$ *and*Y B-algebra and $f: X \to Y$ *B-homomorphism* from X into Y. Then $X/ker(f) \cong Im(f)$. In particular, if$f$ is *surjective* then $X/ker(f) \cong Y$.

Definition 3.8. [9] A BCI-algebra is an algebra $(X; *, 0)$ satisfying the following axioms:

I. $\big((x * y) * (x * z) * (z * y)\big) = 0$,
II. $\big(x * (x * y)\big) * y = 0$,
III. $x * 0 = x$,
IV. $x * y = 0$ and $y * x = 0$ imply $x = y$,

for all $x, y, z \in X$.

BCI-algebra X called BCK-algebra if satisfying$\mathbf{0 * x = 0}$**,** for all$x \in X$.

Example 3.4. Let $X = \{0, 1, 2, 3,\}$ be a set with Cayley table as follows:

Table 4

$*$	0	1	2	3
0	0	0	2	2
1	1	0	2	2
2	2	2	0	0
3	3	2	1	0

We have $0 \in X$ and $1, 2, 3 \in X$. Let $x = 1,\ y = 2,\ z = 3$ then from the table we obtain$(1 * 2) * (1 * 3) * (2 * 3) = 2 * 2 * 0 = 0 * 0 = 0$ (axiom I), $\big(1 * (1 * 2)\big) * 2 = (1 * 2) * 2 = 2 * 2 = 0$ (axiom II), $1 * 0 = 0$ (axiom III) and $1 * 1 = 0, 1 = 1$ (axiom IV). Hence,$(X; *, 0)$ isBCI-algebra.

A non-empty subset S of BCI-algebra $(X;\ *,\ 0)$ is called a ***subalgebra***of X if $x * y \in S$, for any $x, y \in S$. The set $P = \{x \in X\ |0 * (0 * x) = x\}$ is called *P-semisimple* part of BCI-algebra X and X is called a *P-semisimpleBCI*-algebra if $P = X$(see [8]).

Definition 3.9. [8] Let I be a nonempty subset of BCI-algebra X containing 0. I is called an *ideal* of X if $y * x \in I$ and $x \in I$ imply $y \in I$, for any $x, y \in X$.

Definition 3.10. [8] A proper ideal I of BCI-algebra X is called *prime* if $A \cap B \subseteq I$ implies $A \subseteq I$ or $B \subseteq I$, for all ideals A and B of X.

Example 3.5. [8] Let $X = \{0, 1, 2, a\}$. Define the binary operation "$*$" on X by the following table:

Table 5

$*$	0	1	2	a
0	0	0	0	a
1	1	0	0	a
2	2	1	0	a
a	a	a	a	0

Then $(X; *, 0)$ is a BCI-algebra and $\{\{0\}, \{0, 1, a\}, \{0, 2, a\}, \{0,1,2\}\}$ is the set of all proper ideals of X. Since $\{0, 1, a\} \cap \{0, 2, a\} = \{0, a\} \subseteq \{0, 2, a\}$, and $\{0, 2, a\} \subseteq \{0, 2, a\}$. Hence, $\{0, 2, a\}$ is a prime ideal of X. By the similar way, $\{0, 1, a\}$ and $\{0, 1, 2\}$ are prime ideals of X.

Theorem 3.11.[3] Every a *commutativeB*-algebra is a *BCI*-algebra.
The converse of this theorem may not true in general.

Example 3.6. [3] Let $X = \{0, 1, 2, 3\}$ be a set with the following table:

Table 6

$*$	0	1	2	3
0	0	0	3	3
1	1	0	3	2
2	2	3	0	1
a	3	3	0	0

Then it is *BCI*-algebra, but not a *commutative B*-algebra, since $3 * (0 * 2) = 0 \neq 2 * (0 * 3)$.

Theorem 3.12.[3] Every *commutative B*-algebra is a *P-semisimple BCI*-algebra.
The converse of this theorem is true in general.

II. Main Result

R.A. Borzooei and O. Zahiri have been discussed the definition of ideal and prime ideal in *BCI* and *BCK*-algebras. In a similar way, we obtain the definition and some theorems of ideal and prime ideal in *B*-algebra. Some other similar properties from *BCI*-algebras as a base of this definition.

Definition 4.1. A non-empty subset S of B-algebra X iscalled**ideal** of X if:

I. $0 \in S$;
II. $b \in S$and$a * b \in S$, implies $a \in S$, for any $a, b \in X$.

Clearly, $\{0\}$ is an ideal of B-algebra X. An ideal S called**properideal if** $S \neq X$ and is called **closedideal** if $a * b \in S$, for all $a, b \in S$. The least ideal of X containing I, the generated ideal of X by I and is denoted by $\langle I \rangle$.

Example 4.1. Let $X = \{0, 1, a, b, c, d\}$is B-algebra with Cayley table as follows:

Table 7

$*$	0	1	a	b	c	d
0	0	a	1	b	c	d
1	1	0	a	c	d	b
a	a	1	0	d	b	c
b	b	c	d	0	a	1
c	c	d	b	1	0	a
d	d	b	c	a	1	0

Let $S = \{0, 1, a\}$, so $0 \in S$. From the table, we have $1 \in S$ and $a * 1 = 1 \in S$, so $a \in S$. Hence, S is an ideal of X and since $1 * a = a \in S$, then S a B-subalgebra. We will be checked, are every ideals in B-algebra is B-subalgebra?.

Example 4.2. Let $X = (Z; -, 0)$ with "$-$" subtraction operation of integers Z. Then, it is easy to prove that X is B-algebra. Let $I = Z^+ \cup \{0\}$ is a subset of X with Z^+ is positive integers, so I is an ideal of X. Since $3, 4 \in I$ and $3 - 4 = -1 \notin I$, hence I is not a B-subalgebra of X.

So, every ideal in B-algebra is not always B-subalgebra. From the definition of B-subalgebra that is closed of binary operation "$*$" and the closed ideal in B-algebra, we obtain that every B-subalgebra is closed ideal in B-algebra.

Definition 4. 2. Let$X$ *is a* B-algebra. A proper ideal M of X *is* called a ***maximal* ideal** of Xif$\langle M \cup \{x\}\rangle = X$, for any$x \in X \backslash M$, where $\langle M \cup \{x\}\rangle$ is an ideal genearted by $M \cup \{x\}$. M isan *maximal* ideal of X ifandonly if $M \subseteq A \subseteq X$ implies that $M = A$ or $A = X$, for any ideal A of X.

Example 4.3. Let $X = \{0, a, b\}$ be a B-algebra with Cayley table as follows:

Table 8

$*$	0	a	b
0	0	0	b
a	a	0	b
b	b	b	0

We obtain the set of all proper ideal of X is $\{\{0\}, \{0, a\}, \{0, b\}\}$. Let $A = \langle a\rangle = \{0, a\}$ and $B = \langle b\rangle = \{0, b\}$, then A and B are maximal ideals of X, becausetherearenoother ideal of X thatcontaining A and B ratherthanitself.

Let A is an ideal of B-algebra X. Then relation θ is defined $(x, y) \in \theta \Leftrightarrow x * y, y * x \in A$ is a *congruence* relation on X, denoted A_x for $[x] = \{y \in X | (x, y) \in \theta\}$. So, A_0 is a closed ideal of B-algebra X. Let $X/A = \{A_x | x \in X\}$, then $(X/A; *, A_0)$ is a B-algebra with $A_x * A_y = A_{x*y}$, for all $x, y \in X$.

Lemma 4.3. Let A and B ideals of B-algebra X such that $A \subseteq B$. Denote $B/A = \{A_x \in X/A | x \in B\}$. Then

I. $x \in B$ if and only if$A_x \in B/A$, for any $x \in X$.
II. $B/A = \{A_x \in X/A | x \in B\}$ is an ideal from X/A.
III. Let A isaclosedideal of X. If I and J are the set of all ideal of X andX/A, respectively, then, the map $f: I \rightarrow J$, is defined by $f(B) = B/A$ is a bijective map. The invers of f is the map $g: J \rightarrow I$, is defined by $g(B) = \cup \{A_x | A_x \in X\}$.

Definition 4.4. A proper ideal S of B-algebra X called **primeideal** of X if $A \cap B \subseteq S$ implies $A \subseteq S$ or $B \subseteq S$, for all ideals A and B of X.

Theorem 4.5. IfMmaximal ideal of B-algebra X, then M is a prime ideal of X.

Proof. Let the sets I and J be two ideals of X. Since M maximal ideal of X, then $I \cap J \subseteq M$. Assume $I \nsubseteq M$ and $J \nsubseteq M$, so there is $i', j' \in M$, so that $i \in I$ and $j \in J$. Thus, $i, j \in I \cap J \subseteq M$. This is imposible, because $i, j \notin M$. Then, it must be $I \subseteq M$ or $J \subseteq M$. Hence, M is aprime ideal of X.

Example 4.4. Let"$-$" subtraction operation in integers, so that $X = (Z; -, 0)$ is B-algebra. If Z^+ is positive integers and Z^- negative integers, then the subsets $E_1 = Z^+ \cup \{0\}$ and $E_2 = Z^- \cup \{0\}$ are two maximal ideals of X. We will be discussed are E_1 and E_2 is the prime ideal of X or not. Let $A \cap B \subseteq Z^+$, if $A \nsubseteq Z^+$ and $B \nsubseteq Z^+$ then $a, b \in Z^+$, so that there exists $-a \in A$ and $-b \in B$ such that $-a, -b \in A \cap B \subseteq Z^+ \cup \{0\}$.

This is impossible, because Z^+ is positive integers, it must be $A \subseteq Z^+ \cup \{0\}$ or $B \subseteq Z^+ \cup \{0\}$. So, E_1 is a prime ideal of *X.* Let $P \cap Q \subseteq Z^-$, if $P \nsubseteq Z^-$ and $Q \nsubseteq Z^-$ then there exists $-p, -q \in Z^-$ such that $p, q \in P \cap Q \subseteq Z^- \cup \{0\}$. This is impossible, because Z^- is negative integers, it must be $P \subseteq Z^- \cup \{0\}$ or $Q \subseteq Z^- \cup \{0\}$. So, E_2 is a prime ideal of *X.*

Theorem 4.6. Let X is a B-algebra. $M_1, M_2, \dots, M_n$ and M are maximal ideals of X such that $\bigcap_{i=1}^{n} M_i \subseteq M$. Then there exists $j \in \{1, 2, \dots, n\}$, such that $M_j = M$.

Proof. Since M is a maximal ideal of *X,* it can be seen from Theorem 4.5 M is aprimeideal of *X,* so that $\bigcap_{i=1}^{n} M_i \subseteq M$ then there existx $j \in \{1, 2, \dots, n\}$ so that $M_j \subseteq M$. Since M_j is maximal ideal of X either, then $M_j = M$.

Let X and Y are B-algebra. The mapping $f: X \to Y$ is called *homomorphism* of B-algebra or *B-homomorphism* if $f(x * y) = f(x) * f(y)$, for all $x, y \in X$. A *B-Homomorphism* called *B-monomorphism* if f is *one-to-one* and *B-epimorphism* if f is onto. A *B-homomorphism*$f: X \to Y$ called *B-isomorphism* if f is *one-to-one* and onto (bijection), and labeled by $X \cong Y$. If $f: X \to Y$ *B-isomorphism* so $f^{-1}: Y \to X$ also *B-isomorphism. Let* $f: X \to Y$ *B-homomorphism*, then the subset $\{x \in X \mid f(x) = 0_Y\}$ of X is called *kernel* of *B-homomorphism*f labeled by $ker(f)$, then $ker(f)$ is closed ideal of *X. AB-homomorphism* is *one-to-one* if and only if $ker(f) = \{0\}$ (see [13]).

Theorem 4.7. Let X and Y are B-algebra and $f: X \to Y$ *B-epimorphism, then*

I. Let A a closedideal of X and B aideal of X containing *A. If* B is a prime ideal of X then B/A is a prime ideal of X/A.

II. Let A is a prime ideal of X and $ker(f) \subseteq A$, then $f(A)$ is a prime ideal of Y.

Proof.

I. Let A is a closed ideal of X and B is an ideal of X containing A, such that $A \subseteq B$. Since B is a ideal of *X,* thenfromLemma 4.3 (II) B/A is a ideal of X/A. Let I and J are ideals of X/A such that $I \cap J \subseteq B/A$, then there exists K and L be ideals of X so that $I = K/A$ and $J = L/A$, thus $K/A \cap L/A = (K \cap L)/A \subseteq B/A$. If B is a prime ideals of X then $K \cap L \subseteq B$ so that $K \subseteq B$ or $L \subseteq B$, then $K/A \subseteq B/A$ or $L/A \subseteq B/A$. Hence, B/A is a prime ideal of X/A.

II. It is known X and Y are B-algebra and $f: X \to Y$ is *B-epimorphism*. A is a prime ideal of X and $ker(f) \subseteq A$, it means $A/ker(f)$. Since $ker(f)$ is a closed ideal of *X,* thenfrom (I) can be concluded $A/ker(f)$ is a prime ideal of $X/ker(f)$. Since $f: X \to Y$ *B-epimorphism*, then from Theorem 3.5, we obtain $X/ker(f) \cong Y$. Moreover, $A/ker(f) \cong f(A)$, can be concluded that $f(A)$ is a prime ideal of Y.

CONCLUSION

From the discussion above, it can be concluded as below:

1. The definition of ideal in B-algebra is equivalent to ideal in *BCI*-algebra. Also, the definition of prime ideal in B-algebra is equivalent to prime ideal in *BCI*-algebra.
2. Every a B-subalgebra of B-algebra X is a closed ideal of X and its convers is true.
3. Every a maximal ideal of B-algebra X is a prime ideal of X.
4. Let X and Y are B-algebra and $f: X \to Y$ *B-epimorphism.* Let$A$ isa closedideal of X and B anideal of X containing *A. If* B is a prime ideal of *X,* thenB/A is a prime ideal of X/A.

5. Let X and Y are B-algebra and $f: X \to Y$ *B-epimorphism.* Let A is a prime ideal of X and $ker(f) \subseteq A$, then $f(A)$ is a prime ideal of Y.

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DEVELOPING STUDENT CRITICAL THINKING ABOUT LEARNING BASED ON CONSTRUCTIVISM

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Abstract

This study aims to discuss an alternative theory that is suitable to improve students' critical thinking skills at a low level of high school. One of the causes of the lack of critical thinking ability of students because during this time in student learning tend to be passive and students are less involved in finding the concept. Therefore needed a way so that teacher can increase activity and ability of critical thinking of mathematics that is through constructivism based learning. The method used in this research is literature research that is by collecting data about constructivism based learning on students' critical thinking skills from various sources such as relevant research, books, etc. After conducting literature studies by citing data from various sources it is suspected that the learning-based constructivism can improve students' critical thinking skills at the level of Senior High School.

Kata Kunci :*Constructivism, Ability Think Critically.*

INTRODUCTION

Mathematics is a tool for developing ways of thinking. Mathematics is needed, both for everyday life and in the face of scientific and technological progress. Therefore, math lessons need to be given to each learner since elementary school. According to Depdikbud (1991: 1), one of the goals is given mathematics in primary and secondary education, that is to "prepare students to be able to use mathematics and mathematical mindset in everyday life".

Mathematics as a basic science learned in every level of education has a function that is as a tool, mindset, and science. Mathematics plays an important role in shaping critical thinking skills, logical, creative, and able to work together. Classroom learning should consider students' mathematical thinking skills as learning outcomes.

Various efforts are made by the government to improve the quality of quality mathematics education, such as improving the quality of mathematics teachers, completing educational facilities and infrastructure, preparing student and teacher handbooks, and improving the curriculum. But the various efforts that have been done have not shown satisfactory results. This can be seen from many students get low score and not yet comprehend the concept of mathematical maximally.

In a study conducted by Novia (2014), the teacher once assigned the students to make some flat drawings and then asked to be able to name the properties and lower the flat wake-up formula itself. This is done in the hope that students can understand the deeper mateti. Then teachers and students draw conclusions and students are given some critical thinking skills. The result of the answer shows that the average of the students' critical thinking skill test reaches 39.72 and only 5 students are able to solve the problem well enough. Most responded briefly with no clear analysis and evidence (not outlining the answers in detail). This leaves the teacher dissatisfied and continues to improve. Students are not critical in solving existing problems. These findings indicate the low quality of students' understanding of mathematics. Students solve many problems without a deep understanding. As a result, students' critical thinking skills do not develop.

The solution given to students' critical thinking skills is improved by providing a constructivism-based learning. Construtivism learning is learning that requires students to participate actively, self-study ability, develop their own knowledge actively, while the teacher only as facilitator and mediator and learning process.

METHOD

This study included a type of literature study. Where literary study is the way used to collect data or sources related to the topics raised in a study. These data sources contain: Student's critical thinking skills and constructivism-based learning. These sources are obtained from journals, theses and internet sites.

RESULT AND DISCUSSION

The ability to think critically is a very essential ability, and function effectively in all aspects of life. Therefore, this critical thinking ability becomes very important in nature and must be instilled early in school, at home and in the community. In the learning process to achieve optimal results are required to think actively. This means that the optimal learning process requires critical thinking from the learner. Therefore, critical thinking is very important in the process of learning activities.

Critical thinking is an intellectual thought process in which thinkers deliberately assess the quality of their thinking, thinkers using reflective, independent, clear, and rational thinking. According to Halpen (in Achmad, 2007), critical thinking is empowering skills or cognitive strategies in setting goals. The process is traversed after setting goals, considering, and referring directly to the goals-is a form of thinking that needs to be developed in order to solve problems, formulate conclusions, gather possibilities, and make decisions when effectively using all those skills in the right context and type. A person who studies mathematics is expected to develop into a person who is able to think critically and creatively to ensure that he is on the right track in solving mathematical problems faced or mathematical material being studied, and ensure the truth of the thinking process that takes place.

By always being a critical individual in learning mathematics, one will be triggered to be creative. To gain clarity or to distinguish between right and wrong, one will seek solutions by using alternative strategies. Critical thinking demands effort, caring about accuracy, willingness, and attitude not easily giving up when faced with difficult tasks. Likewise, the critical thinking requires an openness to new ideas. Indeed this is not something that is easy, but must and still be implemented in an effort to develop thinking skills (Fisher, 2010).

According to Wahidin (Mahanal: 2007), there are several advantages gained from learning that emphasize the critical thinking skills process, namely:

a. Learning is more economical, namely that what is gained and its teaching will last long in the minds of students

b. Tend to increase the spirit of learning and enthusiasm both in teachers and in students
c. Students are expected to have a scientific attitude
d. Students have the ability to solve problems both in the process of teaching and learning in the classroom or in the face of real problems that will be experienced.

According to Effendi (2010: 110) "constructivism approach is an approach that emphasizes the importance of students building their own knowledge through active involvement in the learning process". Most of the time the learning process takes place based on student activity.

According to Akhras (2000: 344) which states that*" constructivist theories of learning emphasise an active and autonomous role for the learners to construct their own understanding through interacting in an environment in wich the knowledge of the domain is not explicitly separated from the context in wich it applies"*.

Constructivism learning is a learning that develops students' thinking in order to gain meaningful learning by working alone and constructing their own knowledge.

According Suparno (1997: 69) elements of constructivism as follows:

1) Orientation. Students are given the opportunity to develop motivation in learning a topic. Students are given the opportunity to make observations on the topic to be studied.
2) Elicitation. Students are helped to express their ideas clearly by discussing, writing, making posters, and so on. Students are given the opportunity to discuss what is being observed, in the form of writing, pictures or posters.
3) Restructuring Ideas. In this case there are three things.
   a) Clarify ideas that are contrasted with the ideas of others or friends through discussion or through the gathering of ideas. Faced with other ideas, one can be aroused to reconstruct his ideas if they are unsuitable or otherwise, become more convinced when the idea fits.
   b) Building a new idea. This happens when in the discussion the idea is contrary to other ideas or the idea can not answer the questions asked by friends.
   c) Evaluating his new ideas with experiments. If possible, it would be better if the newly formed idea was tested with a new experiment or problem.
4) Use of ideas in many situations. Ideas or knowledge that have been formed by students need to be applied to various situations encountered. This will make the student's knowledge more complete and even more detailed with all kinds of exceptions.
5) Review, how the idea changed. It can happen that in the application of his knowledge to the daily situation, one needs to revise his idea either by adding a description or perhaps by changing it more fully.

From the above explanation and the literature study it can be assumed that constructivism-based learning can develop students' critical thinking skills.

CLOSING

From the above allegations allegedly constructivism-based learning can improve students' critical thinking skills. The elements of consrtuctivism namely:

- Orientation is a phase to give students the opportunity to generate motivation for the material they will learn.

- Elicitation is a phase to help learners explore their ideas
- Restructuring ideas consisting of clarification of the phases for students to contrast the ideas that students have with their friends through discussions, building new ideas when discussing ideas in opposition to other ideas, evaluating new ideas with different activities or experiments.
- The application of ideas is a phase for the party to apply the knowledge it has had in various situations encountered
- Review is a phase for students to apply their knowledge to everyday situations.

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IMPROVING THE ABILITY OF MATHEMATICAL REVIEW OF PARTICIPANTSUSING REALISTIC MATHEMATIC EDUCATION (RME) APPROACH

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Abstract

This research is based on the low ability of students' mathematical reasoning. This is because the learning process is tended to be monotonous and separate from everyday experience. Learners are focused to remember the formula and when given the problem with a higher level of ability with different problems learners are not able to finish it well. Teachers' learning has not been able to make learners use their reasoning well to solve math problems. While reasoning is a basic ability that must be possessed learners. So we need a suitable alternative theory to improve students' mathematical reasoning ability. The solution is used as an alternative in improving students' reasoning ability through Realistic Mathematic Education approach. The principle of RME is guided discovery, learning starts from a context close to the learner, and problem solving by the learners themselves can make it active and understand the mathematical material. The research method used is literature study that is by citing data about RME approach from various sources so it is suspected that RME approach can improve students' reasoning ability.

Keywords : *RME Approach, Ability Reasoning.*

PRELIMINARY

Education is a series of empowerment process of potential and individual competence to become a qualified human being. According to the Law of the Republic of Indonesia number 20 of 2003 article 3 on the national education system, the purpose of national education is to develop the potential of learners to become knowledgeable, capable, creative, independent, and become a democratic and responsible citizen. This process also prepares students to be able to explore, discover and forge their potential, and develop it. According to Ihsan (2003: 11) "Learners (guided party) has the potential to develop". Education must be designed so that the achievement of educational objectives and human resources (HR) generated can compete in the middle of globalization competition and able to support the national development (Soyomukti, 2008: 5). Mathematics is a science that plays an important role in education. Math is able to develop critical thinking skills, creative, systematic and logical that can help humans in understanding and resolving various problems.

According to NCTM (2000) there are 5 basic mathematical skills that must be possessed by learners, namely problem solving, reasoning and evidence, communication, connection and representation. Teachers' learning has not been able to make learners use their reasoning well to solve math problems. While reasoning is a basic ability that must be possessed learners. This is in accordance with the results of PISA tests and evaluations (Programme for International Students Assessment) initiated by the Organization for Economic Co-operation and Development (OECD) in 2015 and released December 6, 2016 the performance of Indonesian students is still relatively low. The achievement score of Indonesian students for mathematics is ranked 63 out of 69 countries evaluated. The rating and average score of Indonesia does not differ greatly from previous PISA test results and surveys in 2012 which are also in the low material mastery group. PISA survey results are also supported by the results of TIMSS (Trends in Mathematics and Science Study) survey in 2015 Indonesia occupies the position of 45 of 50 participating countries.

Another study conducted by Dewi (2014) and Saputra 2009 (2009) states that learners tend to be passive in following the learning. Teachers are still focused on existing teaching materials. Teachers provide the material procedurally that causes less process in the students to digest the subject matter and less support the occurrence of processes in students to digest the material actively and konstuktif. So learners are not challenged to learn the material. The material presented is less associated with the real world that is close to the daily life of learners. Consequently what is gained by learners is limited to what is presented in teaching materials used by teachers, so the knowledge they gain does not develop. Another consequence that arises if the problem is left to pass is the ability of students' mathematical reasoning in solving the problem will not develop and increase.

Mathematics is a lesson that requires teachers to engage learners actively in the learning process. Students should not be considered as passive recipients who only accept the concept by simply using certain formulas and procedures to solve a problem. Learners are given opportunities and guided into situations to reinvent concepts in their own way. The goal is to condition learners into learning situations and relate concepts to the experience of everyday learners.

Realistic Mathematic Education (RME) approach is an approach that we can use in teaching mathematics. RME in Indonesia is known as Indonesian Realistic Mathematics Education (PMRI). RME has been developed in Indonesia since 2001. RME is a theory of learning to teach mathematics which was first developed in the Netherlands in 1970 by the Freudenthal Institute. Freudenthal emphasizes the concept of mathematics as a human activity (Van den Heuvel-Panhuizen, 1996). Human activity is related to real life, the real term not only means according to fact but also means as a situation the problems facing students have meaning for them. For that need an effort exploration of various situations or contexts tailored to the cognitive abilities of learners in learning mathematics.

The principle of RME is guided discovery, learning starts from a context close to the learner, and problem solving by the learners themselves can make it active and understand the mathematical material. Learners are given a real problem for them and given the opportunity to solve them. Surely this activity can form the experience for each learner. This experience can create a mathematical understanding. This is in line with Freudental (1991: 95) which states that mathematics must be associated with problems from situations close to the learner.

Realistic Mathematics Education based learning design is considered capable of answering mathematical problems that use context in real life and close to learners. Afri's (2017) study concluded that the application of learning path with RME approach can improve students' mathematical reasoning ability. This is in line with previous research by Fauzan (2002) and Rangkuti (2015). Based on the above description, it is expected that learning with Realistic Mathematic Education (RME) approach can improve students' reasoning ability.

METHOD

This study included a type of literature study. The study of literature is a way to collect data and sources related to the topic raised in a study. The data sources contain reasoning skills and Realistic Mathematic Education (RME) approach. The sources are obtained from journals, books, articles, research reports and internet sites.

RESULTS AND DISCUSSION

Mathematical reasoning is one of the abilities expected of learners in learning mathematics (NCTM, 2000). Reasoning comes from the word of reason which has a meaning of consideration about good bad, thinking power or activities that require a person to think logically. Mathematical reasoning (Ahmad Thontowi, 1993: 78) is a logical process of thinking in the face of problems by following the provisions of the existing provisions. The process of mathematical reasoning ends with a conclusion. So concluded that reasoning is a process of high-level mathematical thinking to draw conclusions based on ideas that have been proven scientifically. Mathematical reasoning is needed to determine whether a mathematical argument is right or wrong and is used to construct a mathematical argument. Basically any math problem solving requires reasoning ability. Through reasoning learners are expected to see that mathematics is a logical or logical study. Thus students feel confident that mathematics can be understood, thought, proved, and can be evaluated.

Sumarmo (2013: 128) reveals that student indicators have mastered the ability of mathematical reasoning are as follows:

1. Drawing logical conclusions.
2. Giving an explanation of the model, fact, nature, relationship or pattern.
3. Use relationship patterns to analyze situations, create analogies, generalizations, and construct conjectures.
4. Applying for an example.
5. Follow the rules of inference, check the validity of arguments, prove and compose valid arguments.
6. Establish direct proof, indirect proof, and proof by mathematical induction.

Indicators of mathematical reasoning ability according to NCTM (2000: 56) are:

1. Recognizing and believing that giving reason (reasoning) reason and form of proof is a fundamental aspect in learning mathematics.
2. Creating and re-examining predicted mathematical estimates.
3. Develop and evaluate mathematical statements and proofs.
4. Selecting and using various forms of reasoning and verification methods.

Based on some opinions of experts above, it is concluded that the reasoning ability indicators are:

a. Construct or assess mathematical conjecture / argument.
b. Doing math manipulation.
c. Give explanation by using the concept and its properties.
d. Describe the logical conclusion of a number of ideas and their relevance.

e. Find the pattern or nature of mathematical phenomena to make generalizations.

Dienes (1971) states that "Everybody knows that mathematics is an abstract subject". Mathematics becomes a problem because of its abstract learning, so it takes a learning process that can turn something abstract into concrete. Math classroom exploration is emphasized on the interrelation between mathematical concepts and the experience of everyday children. Freudenthal (1991) says that when children are separated from their daily experiences, the child will quickly forget and can not apply mathematics. Therefore, for learners to have good mathematical reasoning skills required an approach that can connect the life experiences of learners with new knowledge to be learned. One of the mathematics learning that begins from the experience of everyday learners and applying mathematics in everyday life is realistic mathematics learning.

According to Susanto (2014: 205) RME is one of the learning approach of mathematics oriented to learners, that mathematics is human activity and math have to be connected significantly to context of everyday life of learners with experience of learning which oriented to things that real (real). Furthermore, According to Baker (1970) that the main principle of RME is that mathematics should always be meaningful to learners. The term 'realistic' emphasizes that the problem situation should be 'experientially real' for learners. This does not necessarily mean that the problem situation is always encountered in everyday life. Learners can experience abstract mathematical problems as real when the mathematics of the problem is meaningful to them.

Mathematical learning by using the RME approach will be oriented to real issues especially those related to the lives of learners. Such an approach will make it easier for learners to digest and understand every thing learned in mathematics. Because the example of the problem taken not far from his life. This kind of learning will transform the abstract mathematical property to the concrete or the real. Not only that, through RME, mathematics learning will create a fun and meaningful because learners are not only demanded on the mastery of the concept alone but rather the ability to solve the problems of mathematics and the way of thinking in solving any mathematical problems.

In RME, the mathematics is seen as a human activity (humanactivity), so that the learning activities carried out by using a real context and appreciate the ideas of learners in working on mathematical problems. Gravemeijer (1994), suggests three principles associated with Realistic Mathematics Education (RME), namely:

1. The rediscovery under guidance (guided reinvention) and mathematical progressive (progressive mathematization). Guided discovery may also be inspired by informal settlement procedures. Then an informal strategy is useful to lead to more formal procedures. To support the process of getting the procedure varied solutions, are expected to follow the progressive learning through the mathematical process.
2. Didactic Phenomenology (didactical phenomenology). Situation in the didactic phenomenology of applied mathematics topics to investigate two things, uncovering parts of the application and complete the process of progressive mathematization.

3. Development of self-developed models. This principle is used to bridge the distinction between informal knowledge and formal mathematics.

The principle of RME is appropriate for improving students' mathematical reasoning abilities. The discovery of the concept of return demanded by the teacher is needed in reasoning activities. This is triggered by the horizontal and vertical process of mathematization done in solving contextual problems in RME. The process of horizontal mathematization can train students' reasoning abilities inductively, as they are given the opportunity to reason using their own ideas. These informal ideas are speculated by the teacher to develop into more mathematical (formal) ideas through a vertical mathematical process. This conditioning has encouraged the development of students' deductive reasoning.

As the operationalization of the three main principles of RME above, according to Freudenthal (in Gravemeijer, 1994), RME has five characteristics:

1. Using contextual issues (The Use of Context); Learning begins with contextual issues that enable learners to use their previous experience and initial knowledge directly, not starting from the formal system. Contextual issues raised as initial materials in learning must be in accordance with the reality or environment faced by learners in their daily life that is understood or easily imagined. According to Treffers and Goffre (in Suherman et al., 2003: 49-150), the contextual problem in RME has four functions:
   a. to help learners in the formation of mathematical concepts.
   b. to form a basic mathematical model in support of mathematical learner pattern patterns.
   c. to utilize reality as the source and domain of mathematical applications.
   d. to train the ability of learners, especially in applying mathematics to real situations (reality). Reality is meant here is the same as contextual.
2. Using vertical instruments such as models, schemes, diagrams, and symbols (use models, bridging by vertical instruments); The term model relates to situations and self-built mathematical models, which are a bridge for learners to create their own models from real to abstract situations or from informal to formal situations. This means that learners make their own models in solving contextual problems which is the relationship between real-world situational models that are relevant to the environment of learners into the mathematical model. So in the process of horizontal mathematization can go to vertical matematisasi.
3. Using student contribution; Learners are given the widest opportunity to develop informal strategies that can lead to the construction of various procedures to solve the problem. In other words, a large contribution in the learning process is expected to come from learners, not from teachers. This means that all the thoughts or opinions of learners are noticed or appreciated.
4. Interactivity: Optimizing the learning process through interaction among learners, students with teachers, and learners with facilities and infrastructure, is important in RME. Interaction forms such as negotiation, explanation, justification, approval, question, or reflection are used to achieve the informal mathematical knowledge form that the learners find themselves. Teachers should provide opportunities for learners to communicate their ideas through interactive learning.

5. Associated with other topics (intertwining); The various structures and concepts in mathematics are interrelated, so that the linkage or integration of topics or subject matter needs to be explored to support meaningful learning. Therefore in RME the integration of mathematics learning units is essential. By integrating it will make it easier for learners to solve the problem. In addition, with the integration of learning, the learning time becomes more efficient. This can be seen through a given contextual problem.

The characteristics of RME above are well suited to achieving reasoning indicators in enhancing students' reasoning abilities. Based on the description above, so that researchers believe by applying the approach of Realitic Mathematic Education (RME) in learning mathematics can improve students' mathematical reasoning ability. This is in accordance with Fauzan (2013) research that RME has a better effect than conventional approach in improving reasoning ability. This is triggered by the horizontal and vertical process of mathematization done in solving contextual problems in RME. The process of horizontal mathematization (solving mathematical problems using informal ideas) can train students' reasoning abilities inductively, as they are given the opportunity to reason with their own ideas. These informal ideas are speculated by the teacher (through the next contextual questions) to develop into more mathematical (formal) ideas through a vertical mathematical process. This conditioning has encouraged the development of students' deductive reasoning.

Further Research Ramadoni (2016) which shows that the design of learning that is developed by using the approach of Realitic Mathematic Education is effective in terms of impact of students' mathematical reasoning ability. It also can grow a positive attitude that learners love to learn, the more creative, learners start accustomed to reasoning and increased student interaction. Steffani's research (2017) shows the learning path, RPP and IT media developed using the RME approach effectively and can develop students' mathematical reasoning abilities.

This has also been studied by previous researchers namely Fauzan (2002), Kwon, et. Al (2013), Rangkuti (2015), Yulinasari (2016), and Sary (2016). Based on the description and supported by some relevant previous researcher, it is assumed that applying Realistic Mathematic Education (RME) learning approach to mathematics learning will improve students' mathematical reasoning ability.

CONCLUSIONS AND SUGGESTIONS

The Realistic Mathematic Education (RME) approach can improve students' mathematical reasoning abilities because the Realistic Mathematic Education (RME) approach is an approach that puts the reality and experience of learners as the starting point of learning in which learners are given the opportunity to construct their own formal mathematical knowledge through problem- The realities of reality. Based on literature studies that have been done, the authors suggest:

1. Teachers can use Realistic Mathematic Education (RME) approach as one of the alternatives used in mathematics learning to improve students' mathematical reasoning ability.
2. The next author should examine more broadly the approach of Realistic Mathematic Education (RME) in improving the ability of other mathematical thinking than the ability of reasoning.

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THE IMPLEMENTATION OF APOS MODELIN TRANSFORMATION GEOMETRY COURSE

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Abstract

In Transformation Geometry, students are required to have spatial visualization capabilities and geometric reasoning for mathematical proofing, which in reality is still be an obstacle for them. Therefore the researchers implemented a Mathematics Learning Model based on APOS Theory (APOS model) in the Geometry Transformation course in order to found out how this model could give a positive effect on students. This APOS model integrated the use of computers, small groups learning, and payed attention on the APOS (Action, Process, Object, Schema) mental constructions which students make in understanding a mathematical concept. The syntax of this model consists of phases: orientation, practicum, Group Discussions, Classroom Discussions, Exercise and Evaluation. The Supporting system used was APOS Model Worksheet and Geogebra software. The subjects of this study were the fifth semester of mathematics education students in A class of FKIP University of Bengkulu. The study was conducted in three cycles of Classroom Action Research process for the dilation, half-turn and composition of transformation subjects. Data on this study were obtained from test sheets, questionnaires, and observations. The result of this research showed that APOS model had give the positive effect in Transformation Geometry lectures based on the student learning result, students' activities and student's responses to APOS model.

keywords : *APOS-model, classroom action research, transformation geometry*

INTRODUCTION

The transformation geometry is important to be studied for supporting the problem solving process (NCTM, 2000; Maharajh, et al., 2008). This, according to Patterson, (1973 in Albab, 2014) can enrich students' thoughts, imaginations and experiences in concepts of symmetry, congruence, parallel lines and others. Hollebrands (2003 in Guven, 2012) also bring up three main reasons for measuring the geometry of transformation: 1) giving opportunity to remember important mathematical concepts (such as function and symmetry); Enables students to view mathematics as an interconnected discipline; And 3) provide an opportunity to participate in high-level reasoning activities using various representations.

Besides being important, the Transformation Geometry course is a course that has a high degree of difficulty. According to Edwards (1997 in Albab, et al., 2014), one is required to have spatial visualization ability and geometric reasoning for mathematical proofing in transformation Geometry.

Based on previous experience of Transformation Geometry learning, students are still having difficulties in applying the concepts of geometric transformation in solving problems due to forgetting the theories they've learned earlier. Students are still having difficulties in making visualization of mathematical problems. Lack of visualization capability can leads to the difficulties in analysis and problem solving, as well as proofing the properties of Transformation Geometry.

In our view, the practice of problem solving and analysis process by making spatial visualization should not be separated by the study of theory in understanding the concepts of geometry transformation. This is because visualization of the problem itself is an important point for students in the process of understanding, reasoning and geometric proofing. Therefore, it is necessary to apply a learning model that emphasizes practicum and problems discussions in the Transformation Geometry course, unlike previous experience, where practicum activities are more applicative, after several meetings studying the concepts and theories.

One of the learning models that can solve the problems in this transformation geometry is the APOS Model. This model was developed in previous studies for Calculus learning (MPK-APOS). The syntax of this APOS Model consists of phases: Orientation, Practicum, Group Discussion, Class Discussion, Exercise and Evaluation. (Hanifa, 2015). APOS model itself is developed based on APOS learning theory, which integrates the use of computers, study in small groups, and pay attention to the mental constructions made by students in understanding a mathematical concept. These mental constructions are: action, process, object , and schema abbreviated as APOS (Dubinsky, 2001). This model APOS syntax will be implemented in Transformation Geometry course by integrating the use of Geogebra computer application.

Geogebra is an application with complete and dynamic geometry transformation features and supports the manipulation of geometry objects. With this application, students will be helped in making visualization of the problems, making it easier in the analysis process (Thohirudin, et al., 2016). Majerek (2014) said that Geogebra helped solve mathematical learning problems such as the difficulty of illustrating mathematical concepts precisely as well as the subject matter and mathematical graphics that are static when drawn on paper, thus not favoring generalization. Therefore, the purpose of this study aims to find out how the implementation of APOS Model can provide a positive effect for students in the course of Transformation Geometry. The following APOS model is implemented in this research.

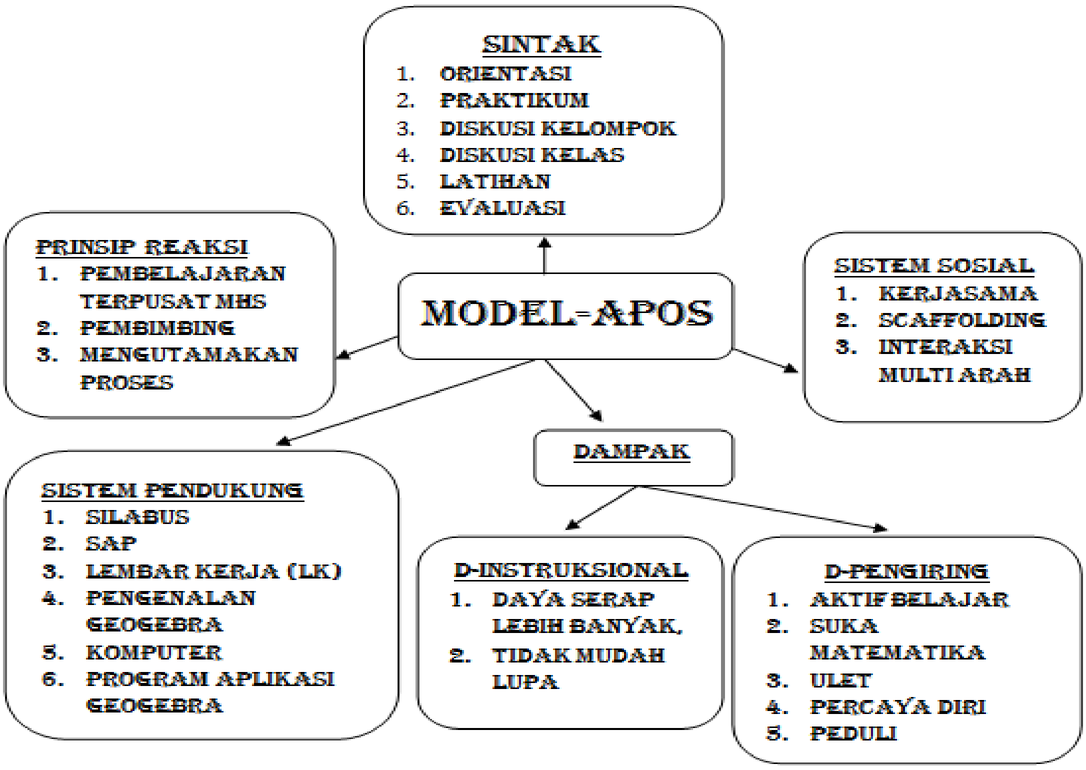

Figure 1. APOS Model in Mathematics Course (Hanifah, 2015)

METHOD AND DESIGN

This research uses the classroom action research procedure, with three stages in each cycle (planning, implementation and observation, reflection) (Arikunto, 2013). This research was conducted in three cycles on the fifth semester of mathematics education students in A class of FKIP University of Bengkulu, that was on dilation, half-turn and composition of transformation course. The data were analyzed by descriptive qualitative. Data obtained from questionnaire, observation, and test result.

FINDINGS AND DISCUSSION

In the APOS Model, students work in small groups, Geogebra assisted, complemented by APOS Model-Based Worksheets consisting of: Practical Worksheet (LKP), Manual Worksheet (LKM), Class Discussion Sheet, and Exercise.

Three cycles of lecturing that have been implemented showed positive effects on learning outcomes, activities, and student responses in the Transformation Geometry course. The following diagram shows the practicality of the worksheet and the student's response to the learning with the APOS Model that has been implemented.

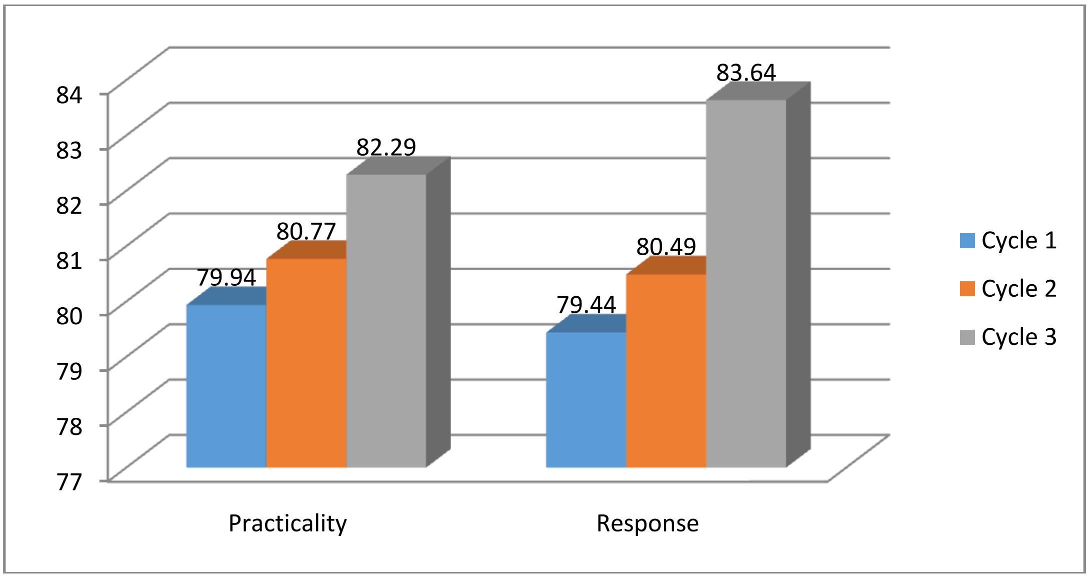

Figure 2. The average score of worksheet practicality and student's response

Student learning outcomes in each cycle can be seen from the practicality of the worksheet. The average practicality of the worksheet has increased in each cycle. In cycle 1, in the dilatation material, APOS Worksheet was at the practical category (79.94 points). The description of The student learning outcomes in cycle 1 is as follows.

a) The four groups have not been able to observe that the center of dilation is the point of intersection of lines connecting the origin and the result point. This is because they were mistaken about the concept of lines and segments. When in LK they were asked to connect the origin and the result point with a line, but they only connect the points with a segment, so that for particular positions of object, there were no intersection points of those segments.
b) Five groups difficult to explain the difference of transformation result with scale k and scale 1 / k;
c) Three groups have difficulty in explaining the nature of similar transformations; and
d) All of the groups had difficulty completing the exercises on LK due to less of time.

The worksheet reached the very practical category (80.77 points) in the second cycle of the course for half-turn material. The following are description of student learning outcomes in this cycle.

a) All of groups were able to illustrate the relationship of the origin, the result point and the center point of the half-turn transformation, but other two groups didn't always draw it in every image of the half-turn transformation process.
b) All of groups were able to find the algebraic formula for determining the coordinates of the result point of the half-turn transformation. Even there were several alternative approaches in determining it, those are: 1) by analyzing the relationship pattern of coordinate number of origin and result point, 2) using the concept of reflection, and 3) using the concept of midpoint. This is what is expected in learning using APOS theory, that students can construct their own mathematical

schemes based on the actions, processes and objects they experience and explore(Suryadi, 2010).

c) Only one group has difficulty in explaining the properties of half-turn transformation.
d) All of groups still feels lack of time. This is due to the interference from other lecturers so that our course were late to be implemented.

The practicality of the worksheet again increases in the third cycle, with 82,29 points of practicality, the worksheet is in very practical category. In this cycle, students had been able to build a scheme of understanding independently. Two groups have showed a deep understanding in completing the worksheets, they add the supporting rationales and theorems to prove the results of the transformation very well. Bhagat & Chang (2014) stated that integrating Geogebra in learning can bridge students' understanding with geometry learning.

However, some obstacles are still encountered in the lectures of this third cycle, among others:

a) Only two groups correctly draw the vector in step 7 of the Practicum Worksheet. Two groups mistakenly draw vectors as segments, and four groups do not draw them at all. Although the Geogebra procedure had been done correctly.
b) The composition transformation was complex, so the students become careless and felt the time given is not masksimal for discussion.

Learning outcomes data was also obtained from test scores given at the last meeting of learning. Overall, 77% of students obtained the test results with a score between 70 and 95 points. Based on the results of the test, the average of student score was 75.85 points which is in effective category.

Student learning outcomes are certainly caused by the positive response of students to learning this APOS Model. Figure 1 shows that student responses are in good category starting from cycle 1 with average questionnaire 79.44 points. This response continues to increase in excellent rates in cycle 2 (80.49 points) and cycle 3 (83.64 points). The increasing of student response also appears in student activities that have increased in each cycle.

Based on student activity observation on cycle 1, the following results were obtained:

a) Ten students still doing other activities outside the task, for example do not pay attention to the explanation of lecturers and exit the room.
b) One group can not cooperate well in groups.
c) Five groups still had minimal interaction and minim in putting forward opinions in the group, there is still a domination of smart students.
d) The Initiatives to present the results of their group discussions in front of the classroom still come from certain individuals, not by group agreement.

Some students' activities have improved, but there were also obstacles that occur that affect student activity on cycle 2. Here are the result of observations.

a) 75% of students arrived late due to the interference of other lecturers who have schedules before the course of Geometry transformation.
b) 5 students still do other activities outside the task, such as not paying attention to the explanation of lecturers and out of the room.
c) All of groups had been able to cooperate well.
d) Only 2 groups are still dominated by smart students.

e) Initiatives to present the outcomes of the discussions ahead are no longer from certain individuals, but based on the group agreement. During the presentation, there was good cooperation from all the group members in explaining, writing on the board, and responding to other group questions.

The enhancement of student activity is better in cycle 3. Active discussion occurs among students in building their understanding scheme independently. Lecturers facilitate lectures by providing assistance in the form of questions that lead to student thoughts and analysis. In this cycle, the lecturer gives more attention to the students who in the previous cycles were less active. With the right encouragement and assistance, the course can be active and conducive. In the phase of class discussions almost all groups volunteered to be the first group to present their group works. Very active students make lecturers overwhelmed in facilitating the discussion of each group. Fortunately the course was held with two lecturers as a team, so it helps the course of lecturing activities with the majority of students who are already active.

The reflection on each cycle be the basis for the improvement of the action given in the next cycle. The following actions are applied in cycle 2 based on reflection on learning outcomes, student responses and activities on cycle 1.

1) Dissolve 1 group that can not cooperate in cycle 1, and incorporate its members into other groups that have already seen their group cooperation. This is done so that each member can follow the pattern of cooperation of other groups that have been formed, so they can learn and cooperate well.
2) Organize the seating of each group so that the smart students are in the middle, so that they can better share the discussion with their group mates.
3) Correcting the Worksheet to be completed according to the time available. In cycle 1, each stage of object transformation is described in each work box. For cycle two, all stages of object transformation are described in one work box only. So students do not have to repeat some of the same images on some work boxes. In addition, the work box provided to draw the results of Geogebra execution was also be enlarged. Apperception of lines and angles is reinforced in the introduction of learning .

Furthermore, in cycle 3, the following actions are applied as improvement of lecture based on reflection on cycle 2.

1) Changing the course schedule that is not disturbed other previous courses.
2) Replace a larger room with an easy chair position.
3) Distribution of groups is maintained, so no adaptation and cooperation among members increases.
4) Designing Worksheets to be completed according to the time available.
5) Giving more motivation to passive students to be more active in discussing and confident in presentation.

CONCLUSION

Implementation of APOS model can give a positive effect on learning outcomes, activities and student responses on lectures Geometry Transformation. These positive effects can be obtained by:

1) Designing Worksheets in accordance with the phases of the APOS Model, with steps students can understand, facilitating the exploration and formation of understanding schemes, and appropriate with the time available.
2) Integrating the use of geogebra at the practicum phase as efficiently as possible.
3) Dividing the group heterogeneously based on students' abilities, skills and personality.
4) Facilitating students with help questions that lead to the establishment of schemes independently.
5) Giving more attention and motivation to less active students.

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DEVELOPING STUDENTS' REASONING ABILITYBY USING M-APOS THEORY

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Abstract

The purpose of learning math is to enable the students to think logically. As the result students are able to understand the existing math concepts beside understanding the formula given or strengthening given by the teacher. For almost all of the problems faced by the student, it is found that by using the reasoning ability, the students were be able to solve it. One of the alternative respounding the students' limitation is by using the M-APOS. As it is known, M-APOS is implemented with ADL cycle (Activities, class discussions, exercise). The method used in this study was the literature study. From the study, allegedly M-APOS can develop students' mathematical reasoning abilities. Action is an action or action where students receive external stimuli. The indicators of the reasoning skills are developed on serving statement by oral mathematics, writing, drawings and diagrams, filed allegations. The process is students repeat and reflect an action. In the process of reasoning the ability of reasoning suggests and performs mathematical process. Furthermore, the object is to understand the process to its fullest and can realize it. In this object indicator draw conclusions, compile evidence, reasoning or evidence against some solutions. The scheme is that students were able to connect multiple actions, processes, and objects. In terms of developing the reasoning ability, the students were able to draw conclusions and find Patterns or properties of mathematical phenomena to make generalizations.

Keywords: *M-APOS theory, the student reasoning ability*

PRELIMINARY

Learning mathemathics requires the ability to fix and change the fact and skill, besides emphasizing more on the importance of assuming, communicating, solving problems and think logically.This means that learning mathematic is not only learning it as a fixed and unchanging collection of facts and skills, but it must be an emphasis on the importance of conjecturing, communicating, problem solving and logical reasoning (Conway & Sloane in Achmad Mudrikah, 2016).

Basically, doing math process is equal to an action, where, when students perform these actions in a regular way, called a process. When students realize and understand, coding them into an object, actions, processes, then objects are arranged in a coherent thought called a scheme.

The purpose of learning mathematics is to help students to think logically. So that students are able to pass the concepts in mathematics toward the real life. and his students are also able to assume the level of thinking. Math and reasoning are two things that cannot be separated, the material will be easily understood with mathematical reasoning. Bein entiled by the reasoning abilities the students will possibley allow students complete a given problem.

Febrivanny (2014) found that students among 25 student it is only 6 students can completed in reasoning abilities (28%) . It means that the ability of students is still low in case ofreasoning. Theoretically, the students' reasoning ability tend to be low because they have limitation to manipulate the "evidence". Ministry of Education (2006: 42) disclosed a reasoning math ability as one of the goals of mathematics learning is to use reasoning on the pattern and nature of the pattern, perform manipulation to make generalizations, compile evidence or explain mathematical ideas and statements.

M-APOS is assumed as on the sollution in term of increasing the reasoning ability. M-APOS is a modification APOS theory (Action, Process, Object, Scheme). According to Dubinsky five types are important in Piaget's process describes how new objects, new processes, scheme can only develop abstract in mathematics consists of: generalization, interiorization, encapsulation, coordination and reversals. (Dubinsky, E & Tall in Murdrikah, 2016).

The M-APOS method were implemented through cycles ADL (Activities, class discussions, exercise). The process includes: learning phase activity, class discussion phase and doing the exercise. In the activity phase is given in the form of a task through worksheets participants, then the results of the task will be discussed in the next excercise.

METHOD

This research is categorized as literature research which means to use the lit to collect data or resources associated with the topic to study. This research contains about reasoning ability and M-APOS method.

RESULTS AND DISCUSSION

APOS theory and its application to practice teaching is based on the following assumptions: Assumption of mathematical knowledge: mathematics knowledgeg of an individual existence tendency to respond to situations perceived math problem and its solution to reflect on the social context and construct or reconstruct a mental structure that will be used in solving the existing problems (Dubinsky, 2010). Hypothesis on learning: an individual does not learn math concepts directly, he needs the mental structures to understand a concept (Piaget, 1964).

APOS theory is a theory of learning that integrates computers in learning, paying attention to the students' mental construction. These mental constructions are action, process, object, schema (scheme) shortened to APOS (Dubinsky & McDonald in Arnawa, 2009). According to Dubinsky the five types are important in Piaget's process in describing how new objects, new processes, scheme can only develop abstract in mathematics which consists of: generalization, interiorization, encapsulation, coordination and reversals. (Dubinsky, E & Tall, D. in Murdrikah, 2016).

The APOS theory is implemented using the ADL cycle (Activity, Class discussion, Exercise). In the learning there are phases of activity, class discussion phase, training phase. APOS Theory also has many uses in teaching mathematical materials such as arithmetic, algebra, and calculus. Although APOS is a theory that can be used in teaching a variety of mathematical material but APOS is not appropriate to use in teaching materials geometry. However APOS is giving his great contribute cognition understanding of mathematics students (David Tall, 1999).

M-APOS is a modification of APOS where the M-APOS method colors the students tasks, learner's worksheet (LKPD). M-learning process is combined with APOS, using ADL cycle (activity, class discussions, exercise). In the training phase of APOS uses computer while on M-APOS uses LKPD. The class discussion phase and the exercises also colored by APOS.

M-APOS was used as a solution to improve or develop mathematical reasoning skills . In the Ministry of Education (2006: 42) disclosed the mathematical reasoning ability is one learner's goal is to use mathematical reasoning on the pattern and nature of the pattern, perform mathematical manipulation in making generalizations, compile evidence, or explain the ideas and statements in mathematics.

Herdian (2010: 1) argued that "the reasoning is a mental process in developing the minds of some fact or principle." According to Fauzan (2012) The ability of reasoning in mathematics is an ability to use the rules, properties or mathematical logic to obtain a correct conclusion, reasoning can not be separated from the reality, because the mind is a reality, namely " the law of reality" that is in line with the rules of thinking and with a clear basis in reality.

PPPG team in Fauzan (2012) the reasoning includes (1) Presents a mathematical statement, either orally, in writing, drawings and diagrams, (2) Asking alleged (conjectures) (3) Perform mathematical manipulations, (4) Draw conclusions, compile evidence, reasoning or evidence against several solutions, (5) Drawing conclusions from statements, (6) Checking the validity of an argument, (7) Finding the pattern or nature of the symptoms of mathematical generalization. According to Fauzan (2012) reasoning can be classified into two types: inductive reasoning and deductive reasoning. Inductive reasoning can be interpreted as a general or drawing the specific conclusion is based on the data that was observed. Some activities that belong to inductive reasoning include: (a) transductive which draw conclusions from the case or the special nature applied to other special cases. In general, transductive is considered as the low-level of thinking ability. (b) An analogy is a general conclusion based on both the data process and the similarities. (c) Generalization is a general conclusion based on a number of the data. (d) Expected answers, solutions and tendency. Deductive reasoning can be interpreted withdrawal based on the agreed rules.

According to the theory of APOS, the concept of mathematics is built like an experiment to transform a real form or an object. Here are the descriptions of APOS (Arnon and Dubinsky, 2009): Action: The first thing students experience in a transformation is action \ students react to the stimuli coming from outside. For example, students show the nature of the curiosity or do the task given by the teacher. By having the curiosity as the respound to the stimulation provided by the teacher, the students' reasoning ability will be reactively work because students think by responding logically. In this action, is done through oral mathematics, writing, drawings and diagrams and proposed conjecture which will be used or developed. In the phase of process students repeat and reflect the actions which incorporated into the mental process. A process is a mental structure that performs the same operation as an action, but it is entirely work in the students' mind. Paticularly, students can imagine performing transformations or action without explicitly doing each step. The indicator is if the students do reasoning and do math better. Object: if students understand the process that was optimally done and can realize it, it means that the student is doing the process of cognitive object. Scheme: This happen when the students can connect some actions, processes and math objects coherently. In the term of scheme students will be able to draw conclusions and find the pattern or nature of the mathematical generalization. Considering both the explanation, and literature studies above, it can be expected that M-APOS can develop and improve students' math skills.

CONCLUSSION

From the description suggest that M-APOS can improve or develop students' reasoning abilities. Action is the act or actions after the students receive stimuli from the outside. In action, the indicator reasoning ability is shwn by presenting statements by oral mathematics, writing, drawings and diagrams, and filed allegations. The process occure at this stage is by repeating and reflecting on an action. The ability of reasoning suggests and performs mathematical manipulates. The object is to understand the process to its fullest and can realize it. The indicators are to draw conclusions, compile evidence, reasoning or evidence against some solutions. The scheme is that students are able to connect multiple actions, processes, and objects. In this scheme indicator developed reasoning ability, draw conclusions and find pattern or mathematical nature to create generalizations.

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EFFECTIVENESS THE IMPLEMENTATION OF CONTEXTUAL MATHEMATICS TEACHING MATERIAL INTEGRATED RELATED SCIENCES AND REALISTICFORSTUDENTSGRADE XI SENIOR HIGH SCHOOL

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Abstract

Mathematics is an important science for life and other knowledge. In other knowledge, mathematics is often used as a tool for thinking and solving problems. For this reason, mathematics learning should integrate related sciences and real problem solving. In this way, the mathematics learning is realistic, interesting and meaningful. However, the reality shows that mathematics learning material used by the students in grade XI senior high school has not been associated with other sciences and everyday life. As a solution to this problem is to develop contextual mathematics teaching material integrated related sciences and realistic. The purpose of research is to produce a contextual mathematics teaching material integrated related sciences and realistic for students grade XI senior high school.The specific purpose is to determine effectiveness of contextual mathematics teaching material integrated related sciences and realistic The research method used is development research, that is a method to produce a certain product and test the effectiveness of the product. The research result is an effective contextual mathematics teaching material integrated related sciences and realistic produced. Thiscontextual mathematics teachingmaterial is effective in terms of the learning result achieved by the students, that is the change of student learning outcomes.

Index Terms **:***Effectiveness, mathematics, contextual, related sciences, realistic*

INTRODUCTION

The lessons that teachers need to apply in the 21st century are four principles. First, student-centered learning. Second, learning takes place collaboratively. Third, learning has context. Finally, schools are integrated with the community.In the 2013 curriculum, mathematics is one of the required subject. This is because, mathematics is one of the basic science used to support other sciencessuch as physics, chemistry, computers, and others. In addition, mathematics is a universal science that underlies the development of modern technology.

Mathematics has an important role in various disciplines and advances the human mind. Mathematics is not only a tool for mathematics itself, but many of its concepts are indispensable to other sciences. Seeing the importance of mathematics is not surprising that mathematics has been studied extensively and fundamentally since primary school education.

The Regulation of the Minister of National Education of 2006 on content standards states that subjects of mathematics need to be given to all learners from elementary school to equip learners with logical, analytical, systematic, critical and creative thinking skills, and the ability to cooperate. Appendix Permendiknas Number 22 of 2006 states that learning mathematics should be started with the introduction of problems that fit the situation (contextual problem). By posing contextual problems, students are gradually guided to master mathematical concepts. This suggests that in the learning of mathematics should be started with the introduction of problems appropriate to the learning situation and also involves the active role of students in the learning process.

Mathematics also plays an important role in human life. Mathematics is essentially a thought process that involves constructing, applying abstractions, and connecting ideas networks logically. These ideas often arise out of necessity in solving the problems of science, technology, and everyday life. It means there is a very close relationship between mathematics and science. Science provides problems that need to be investigated and analyzed with mathematics, while mathematics provides a useful tool for analyzing data. Often the abstract patterns learned in mathematics are very useful in science. The significance of mathematical concepts is evident when used in solving problems of science, technology and everyday life. In view of this, in mathematics teaching in schools, teachers should link mathematics lessons with other subjects, technology, and everyday life.

The reality in the field shows that the learning of mathematics has been an independent lesson that is separate from other knowledge. Mathematics learning in schools is highly theoretical and mechanistic. Mathematics learning only emphasizes mathematical theories and concepts without its application to other fields such as economics, science, technology, and everyday life. Such learning causes students not to know for what they are learning math. In other words math subjects felt less meaningful to his life. As a result, the learning of mathematics felt less meaningful for the students so that they could cause them less interest in mathematics.

Mathematics learning in practice usually begins with an explanation of concepts accompanied by examples, followed by practice questions. This approach of learning is dominated by the presentation of mathematical problems in a closed form of mathematical problems formulated in such a way that it has only one correct answer with one solution. In addition, these closed issues are usually presented in a structured and explicit manner, beginning with what is known, what is being asked, and what concepts are used to solve the problem. Ideas, concepts and patterns of mathematical relationships as well as strategies, techniques and problem solving algorithms are given explicitly, so students can easily guess the solution. This kind of learning approach tends to only train basic mathematics skills in a limited and isolated way.

Another fact that is found is that the problems presented in most books do not relate mathematics to the context of everyday student life so that the learning of mathematics becomes distant from student life. In other words, math learning becomes less meaningful. Less significant learning for students in mathematics lessons is thought to be the cause of the low interest and achievement of students' math learning.

Mathematics plays an important role in human life. Much of life can not run without a mathematical role. For example, in terms of economics are widely used mathematical formulas namely arithmetica social, percentage (fractional) and comparison. Construction of a building, bridge, overpass, requires trigonometric principles (angles in triangles). Calculating the distance of a place and its relation to the speed of a vehicle, calculating the area of a yard, weighing the weight of a sack of rice or volume of one gallon of water, determining the direction of qibla or other place (with the science of the spherical triangle) and other human activities that can not be separated from the use of mathematical formulas. How important mathematics in support[1].

Mathematics as a basic science plays a very important role in developing science and technology, because mathematics is one means of scientific thinking is needed to cultivate the power of reason, logical, systematic and critical way of thinking [2]. Every beginning of human life mathematics is a tool to overcome every problem facing the environment. The contribution of mathematics to the development of science is clear that even without math IPA will not develop. This is due to the fact that IPA relies on induction methods. By the method of induction alone it is impossible to know the distance between the earth and the moon or the earth in the sun, even to declare the circumference of the earth alone is almost impossible.

Mathematics is useful in science for explaining natural events. For example in physics, there are at least three functions of mathematics. First, mathematics as a symbol or symbol. The role of mathematics in physics to express the term physics such as acceleration is denoted by a. Second, mathematics as a concept map. For the mathematical example used to describe the average velocity depends on two other concepts of moving objects and the time required by the object. Third, mathematics as a mechanism of thinking. For example [3], mathematics can be used to convert a law into a new statement.

Mathematics education should be linked to real-world contexts. Mathematics learning that offers realistic learning characteristics is Realistic Mathematics Learning (PMR). This learning model is an innovation in mathematics learning that has been applied in Indonesia since 1998 and continues to be developed to date [4]. PMR is a mathematical learning approach that uses real situations or contextual problems in accordance with the reality or environment encountered and has been conceived or imagined by students. RME is a theory of teaching and learning in mathematics education that must be associated with reality because mathematics is a human activity. This means [5]that math must be close to the child and relevant to everyday life.

In general, realistic mathematics learning has five characteristics. First, using the context, meaning that in realistic mathematics learning the daily environment or knowledge that has been owned by students can be used as part of contextual learning materials for students. Secondly, using a model, meaning that problems or ideas in mathematics can be expressed in the form of models, both models of real situations and models leading to the abstract level. Third, using student contributions, meaning problem-solving or concept-finding is based on student idea contributions. Fourth, interactive, meaning the learning process activity is built by the interaction of students with students, students with teachers, students with the environment and so on. Fifth, integrated with other learning topics, meaning that different topics can be integrated so as to generate an understanding of a concept simultaneously [4].

Learning must start from something tangible in the PMR, so that students can engage in a meaningful learning process. In the process the role of teachers only as a mentor and facilitator for students in the process of reconstructing ideas and mathematical concepts. In mathematics learning, students can develop knowledge and understanding of mathematics if given space and opportunity for it. Students can re-construct the findings in the field of mathematics through the activities and exploration of various problems, both problems in everyday life, as well as problems in mathematics itself. Inside the PMR students are expected to be not just active individually, but there is a joint activity among them. This is called interactivity [6].

The PMR emphasizes to bring mathematics to meaningful teaching by relating it in real-life daily life that is realistic. Furthermore, students can solve the problem by directly using the concept they have or students solve the problem by changing into a mathematical model and then using the concept that has been owned to solve the problem. Through learning activities with PMR [7] approach students can develop math problem solving skills.

There are three key principles in realistic mathematics learning that can be used as a basis in designing learning. First, guided discovery and increasing mathematical process. Based on the principle of discovery, students are given the opportunity to experience the same process as the process when mathematics was discovered. The history of mathematics can be used as a source of inspiration in learning materials.Second, a phenomenon containing didactic charge. Based on this principle the presentation of mathematical topics contained in the learning of realistic mathematics presented on two considerations are: 1). Raises the variety of applications that must be anticipated in the learning process and 2), its suitability as being influential in the progressive mathematizing process. Mathematical topics presented or contextual issues that will be raised in learning must consider two things namely the application. Third, the formation of the model by the students themselves. Based on this principle of learning [8] while working on contextual problems students are given the opportunity to develop their own models that serve to bridge the gulf between their informal and formal math knowledge.

Based on the principles and characteristics of RME, in general four steps need to be done by teachers in implementing RME learning. Step 1 is to understand the contextual problem. The teacher gives contextual problems according to the subject matter the student is learning and then asks the students to understand the given problem. Step 2 is solving contextual problems, students describing contextual problems, interpreting the mathematical aspects of the problem, and thinking about problem-solving strategies. Furthermore, students work to solve problems in their own way based on their initial knowledge. Step 3 is to compare and discuss answers. Teachers provide time and opportunity for students to compare and discuss their answers in groups, then compare and discuss in class discussions. At this stage, students can be courageous to express their opinions even if they differ from others. Step 4 is to conclude. Based on the results of class discussions [9], the teacher gives the students the opportunity to draw conclusions of a concept or procedure related to the realistic problem being solved.

One alternative solution to solve the problems that have been disclosed is to develop contextual mathematics teaching materials to integrate related knowledge and realistic approach. With this solution, learning takes advantage of real-world situations, engages students actively, and links mathematics with other relevant knowledge. Learning enables students to build and develop ideas and understanding of mathematical concepts widely and deeply, understand the interrelation of mathematics with other fields of science, and be able to apply to various issues of life and life.

The existence of teaching materials is needed in a learning activity. How steady the teachers implement a new curriculum when prepared teaching materials and teachers as well as student teaching materials. Teachers' materials include general guidebooks and special guidebooks. Both as a teacher handbook in providing motivation, develop creations, explore the potential in the learning process to students. Student teaching material [10] is a student handbook as much as possible interesting, fun, bringing students more eager to learn and learn.

The idea of research of development of contextual mathematics teaching material to integrate related knowledge, there is a preliminary study result, that is Helma et al. [11], with the title of improving students' mathematical thinking logic through the implementation of a structured problem-solving strategy using PLT in class XI SMAN 1 Singkarak. The results showed that the application of structured problem solving strategy using PLT can improve mathematical thinking logic of grade XI SMAN 1 Singkarak students.In addition, based on questionnaires given to students obtained information that PLT can help students' learning readiness and motivate students in doing the exercises and homework.

A person's learning outcomes are determined by the factors that influence them. One of the factors that exist outside the individual is the availability of teaching materials that make it easy for the individual to learn, resulting in better learning [12]. Based on the results of this study can be argued that the use of teaching materials in learning to provide various facilities for students so that an effect on student learning outcomes.

METHOD AND DESIGN

The type of research that will be conducted is Research and Development (R & D). R & D is a research method used to produce a particular product, and test the effectiveness of the product. The development model used is Borg and Gall. Borg and Gall stated that the development research procedure basically consists of two main objectives of developing a product and testing the effectiveness of the product in achieving its goals.

Product effectiveness test activity conducted at SMA Negeri 1 Payakumbuh. In product effectiveness test used experimental research method. The experimental class is class XI MIPA 6 and the control class is class XI MIPA 8.

The instrument used to determine the effectiveness of the use of contextual mathematics teaching materials integrates the related knowledge and realistic in learning is the test result sheet. The data analysis used was comparative analysis using t-test and Mann-Whitney test.

FINDINGS AND DISCUSSION

After the product development, tested the effectiveness of the product in achieving the goal. Prior to experimenting on two classes, namely class XI MIPA 6 and class XI MIPA 8, first seen the ability of both classes. The initial capability of the two classes can be seen from Odd semester student learning result of academic year 2016/2017 as in Figure 1 below.

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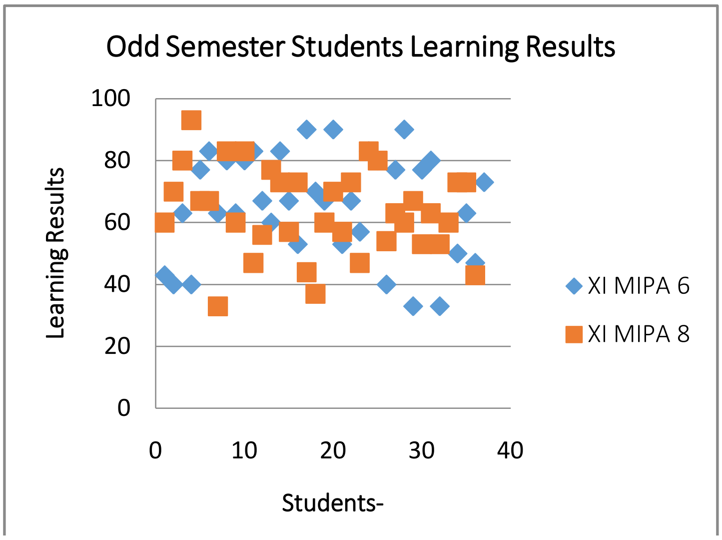

Figure 1. Odd Semester Students Learning Results Of Academic Year 2016/2017 of class XI MIPA 6 and XI MIPA 8

To see if both classes have the same initial capabilities, the following steps are followed.

a. Testing data normality odd semester students learning result of class XI MIPA 6 and XI MIPA 8.The hypothesis is

H_0 : data of student learning result followthe normal distribution
H_1 : data of student learning result does not followthe normal distribution

Test statistic used is The Anderson-Darling. The Anderson-Darling test statistic is defined as

$$A^2 = -N-(1/N)\ \Sigma(2i-1)(\ln F(Y_i) + \ln(1-F(Y_{N+1-i})$$

where F is the cumulative distribution function of the normal distribution and $Y_i$are the ordered observations. The result of normality test for student learning result data of class XI MIPA 6 can be seen in Figure 2 below.

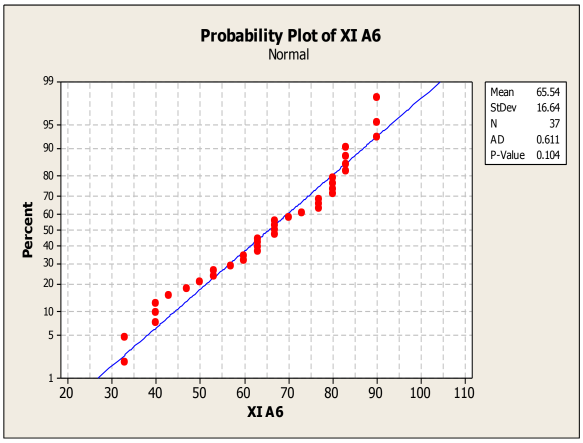

Figure 2. Normality Test for Odd Semester Student Learning Result Data of Class XI MIPA 6

Student learning result data of class XI MIPA 6 can be concluded to be normal distribution. It is seen from the P-value obtained, that is 0.104, greater than the error level given. In this case, the error level given is 0.05.

The result of normality test for student learning result data of class XI MIPA 8can be seen in Figure 3 below.

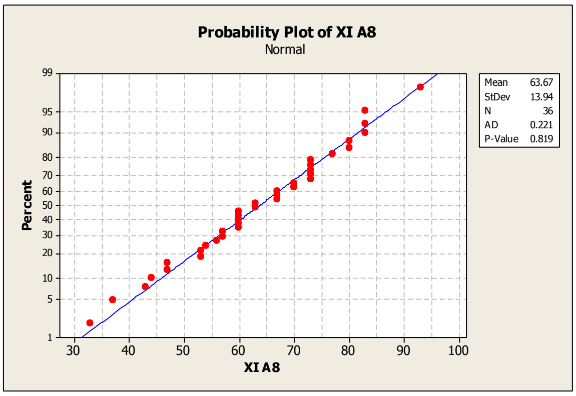

Figure 3. Normality Test for Odd Semester Student Learning Result Data of Class XI MIPA 8

Student learning result dataof class XI MIPA 8can be concluded to be normal distribution. It is seen from the P-value obtained, that is 0,819, greater than the error level given. In this case, the error level given is 0.05

b. Examine the similarity of variancestudent learning result dataof class XI MIPA 8 and XI MIPA 8.The hypothesis is

$H_0 : \sigma^2_6 = \sigma^2_8$
$H_1 : \sigma^2_6 \neq \sigma^2_8$

Test Statistic used is F-test. The F-test statistic is defined as

$F = (s^2_6) / (s^2_8)$

where s^2_6 is the variance of student learning result dataclass XI MIPA 6 and s^2_8 is the variance of student learning result dataclass XI MIPA 8. The result of F-test is 1.43 with P-value obtained 0.297. This means, the variance of the student learning result dataof class XI MIPA 6 is not different from the variance of the student learning result dataof class XI MIPA 8.

c. Testthe similarity of means student learning result dataclass XI MIPA 6 andXI MIPA 8.The hypothesis is

$H_0 : \mu_6 = \mu_8$
$H_1 : \mu_6 \neq \mu_8$

Test statistic used is t-test. The result of t-test is 0.52 with a P-value of 0.604. This means that the means of the student learning result dataclass XI MIPA 6 is not different from the means of the student learning result dataclass XI MIPA 8.
Thus, it can be concluded that both sample classes have the same initial capability

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After contextual mathematics teaching materials integrated related sciences and realistic are given to the learning in class XI MIPA 6, then the student learning outcomes of the two sample classes are shown. The test value of student learning outcomes from both classes can be seen as in Figure4 below.

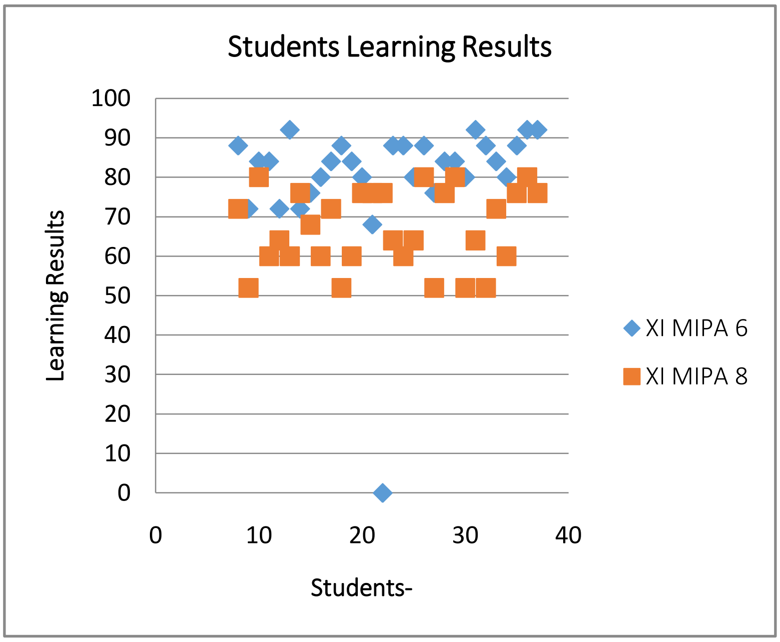

Figure 4. Students Learning Results of class XI MIPA 6 and XI MIPA 8

To look whether the value of the test results of students learning class XI MIPA 6 is different from the value of the test results of students learning class XI MIPA 8, then performed the following steps.

a. Testing data normality students learning result of class XI MIPA 6 and XI MIPA 8.The result of normality test for student learning result data of class XI MIPA 6 can be seen in Figure 5 below.

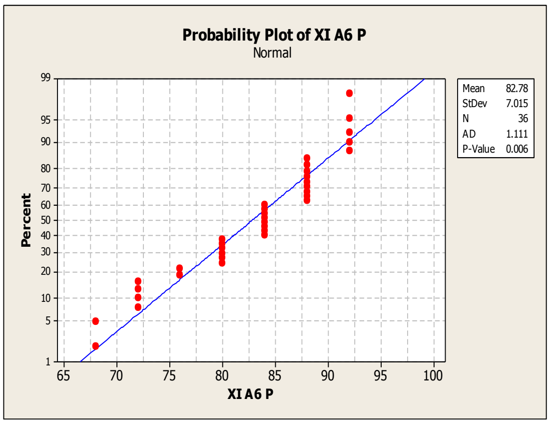

Figure 5. Normality Test for Student Learning Result Data of Class XI MIPA 6

Data test result of student learning class XI MIPA 6 can be concluded not normal distribution. It can be seen from the P-value obtained, that is 0.006, smaller than the given error level. In this case, the error rate given is 0.05

The result of normality test for student learning result data of class XI MIPA 8can be seen in Figure 6 below.

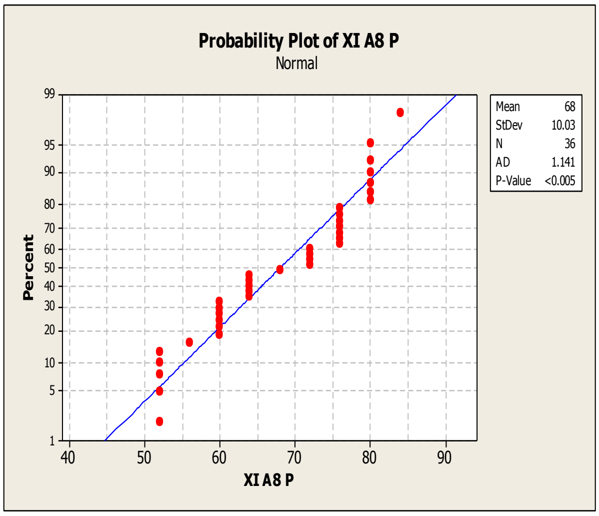

Figure 6. Normality Test for Student Learning Result Data of Class XI MIPA 8

Data value of test result of student learning class XI MIPA 8 can be concluded not normal distribution. It is seen from the P-value obtained, ie <0.005, smaller than the given error level. In this case, the error rate given is 0.05.

The data of test result of student learning result of class XI MIPA 8 and class XI MIPA 8 are not normally distributed. To test the similarity of students' ability in both classes after having contextual mathematics teaching materials integrated related sciences and realistic, median equality test was used.

b. Test the similarity of median student learning result dataclass XI MIPA 8 and class XI MIPA 8.The hypothesis is

$H_0 : \eta_6 = \eta_8$
$H_1 : \eta_6 \neq \eta_8$

Statistic test used is Mann-Whitney test. The result of Mann-Whitney test is 1812.0 with P-value obtained 0.0000. This means that the median student learning result dataof class XI MIPA 6 is different from the median student learning result dataof class XI MIPA 8.

Thus, it can be concluded that the two sample classes have unequal ending capabilities. Thus, contextual mathematics teaching materials integrated related sciences and realistic produced increase the student learning outcomes.

CONCLUSION

The research result is an effective contextual mathematics teaching material integrated related sciences and realistic produced. Thiscontextual mathematics teachingmaterial is effective in terms of the learning result achieved by the students, that is the change of student learning outcomes.

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INFLUENCE APPROACH REALISTIC MATHEMATICS EDUCATION TOWARD STUDENT'S ABILITY OF PROBLEM SOLVING AND MATHEMATICAL COMMUNICATION GRADE VIII SMP NEGERI SOUTH NIAS REGENCY

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Abstract

Ability of Problem Solving (APS) andAbility of Mathematical Communication (AMC) isessential in the achievement of the objectives of the learning of mathematics. But in fact, in the process learning that happen lately capability APS and AMC students in school is still very low in particular SMP Negeri in South Nias Regency. In addition, in the process of learning, students have been lazy and feel less interested in following instruction. Most confused myself and looks like the following learning besides they do not understand it. This is apparent from the results of the exams of the semester grade VIII SMP Negeri in South Nias Regency on 22 June 2017, most students difficult to solve problems concerning the APS and AMC, so that shows the APS and AMC of the students is low. This is because the given learning strategies teacher is conventional learning. Based on the results of research that has been done by previous researchers, solutions to improve the APS and AMC students in the writing of this learning approach is to apply Realistic Mathematics Education (RME). Where the RME approach creates learning is contextual, invites students to the neighborhood where he resides and connect it to math. The results can improve the APS and AMC students and creates a fun learning. The methods used in this research is a research study of literature by collecting data the results of the research on the application of the RME, APS,AMC and learning motivation of students from a variety of sources such as relevant research, books, journals, etc. After conductinga study of the literature then alleged APS and AMC through the approach of learning motivation of RME is very good compared with the APS and AMC through conventional learning.

***Keywords**: Approach RME,Ability of Problem Solving, Ability of Mathematical Communication, and Learning Motivation.*

INTRODUCTION

Education is a container in shaping the character of each individual to reach something that's called learning. Dictionary Of Education (Ihsan Fuad, 2005:4) States that education is a process by which a person develops the ability of attitudes and forms of behaviour within the community in which he lives, a social process in which a person is exposed to the influence of the environment chosen and controlled (especially coming from school) so he can gain developmental experience or ability of the individual resources. Education in schools that goes on in particular is a place where students are guided through a variety of activities to develop knowledge in order to become a useful human being.

Mathematics is one of the subjects that must be followed by all students and become a determinant of success a student (Armiati, 2015:75). Most students assume math is not difficult, the lessons interesting and less rewarding. As a result when the execution of the test, most students cheating resorting of confusion and his friend (Armiati, 2015:75). It can be seen from the results of an observation that has been made by researchers against two junior high school in South nias Regency i.e. class VIII SMP Negeri 1 Telukdalam and class VIII SMP Negeri 3 Maniamolo. Based on data obtained from the results of interviewing teachers and students, student learning and outcomes observation learning-related problems such as problem-solving and mathematical communication, its average was 63.8 and 60.6 it still under KKM i.e. 65. In addition students are encouraged in doing only a matter of compliance provided teachers and guided by a book without understanding and observing the learning goals and purpose. So the students interpret whether material benefits that he learn? How to do in real life? In addition how to troubleshoot and solve problems of mathematical communication? This greatly affects student learning outcomes i.e. If the student is confronted with problems such as problem-solving ability and mathematical communication related to everyday life will make students overwhelmed and hard to understand, but the questions he already learned. Then through the learning approach that will be applied by the researchers in this study, can help improve the ability of the mathematical problem solving of students as well as their learning motivation, because in this approach, students demanded more to the environment and real life. Thus the great student learning motivation will it affect the ability of problem solving and mathematical communication students.

Problem-solving ability has long been the focus of major attention in learning math in school. As an example the Nation Council of Teacher of Mathematics (NCTM, 2000) in the United States in 1980 initiated problem solving should be the main focus of the mathematics school. In addition institutions such internasioanal survey research Programe International Student for just my Assesment (PISA) in 2015 is also conducting a survey on a regular basis to see the capabilities of the mathematical problem solving of students who in it is the process of using the power and benefit of mathematics in solving problems, which is also the method of discovery solutions include the stages of problem solving.

In the learning of mathematics, often lack the motivation of learning students because students have the burden of learning a lot. Lace high motivation of learning math students are often associated with the success or failure of students in learning. Students who are actively seeking a job well done, and compare the results with others. One of the factors that influence student learning motivation are characteristics of the subjects studied. In this case it may be suspected that the motivation of learning students against mathematics is a highly influential factors towards the learning results of student learning. This affects the ability of the mathematical problem solving of students declined. Related to the above, the researcher trying to do a research on learning math with the title "Influence Approach Realistic Mathematics Education Toward the ability of problem solving and Mathematical Communication Grade VIII JUNIOR in terms of the motivation of learning". In addition to approach learning, mathematical problem-solving ability of the students in terms of their learning motivation as well. The problem will be answered through this paper is:

1. What is the mathematical problem-solving abilities of students through the learning approach to realistic Mathematics Education is better than on the mathematical problem solving ability students through conventional learning?
2. If there is a difference in the ability of problem solving learning motivation of students with high, medium and low?
3. What is the mathematical communication skills of students through the learning approach to realistic mathematics edication is better than on the mathematical communication skills of students through conventional learning approach?
4. If there are differences of mathematical communication ability with students learning motivation high, medium and low?

METHOD

This research includes the types of research studies literature. Where is the study of literature is the way used to spool the data or resources related to the topics raised in a research. The sources of the data contains: the ability of problem solving, mathematical communication skills, pendekatanrealistic of the mathematics education student learning and motivation. The resources obtained from journals, books, articles and research reports on internet sites.

DISCUSSION

RME is the mathematical learning theory developed on the basis of thought Freudenthal in 1973. He said that mathematics is a human activity and should be linked to reality. Freudenthal argued that students cannot be seen as passive recipients of mathematics already so. Mathematics education should be directed at the use of the variety of situations and opportunities that allow students rediscover (reinvention) math based on their own efforts. RME is an approach to learning mathematics-oriented process Real world mathematical process (Mathematization) which is often encountered in everyday life. This approach to Theory is based on the view of Freudenthal that mathematics is a human activity and must be connected with reality (Hirza B, 2014:29). In addition Freudenthal (Mercure, 2003:10) convinced that the structure of mathematics is not a fixed datum, but that they appear from the reality and extending constantly in the process of individual and collective learning. In other words, in the RME students are viewed as active participants in the process of teaching and learning that takes place in the context of social class.

According to Gravemeijer (Hirza, 2014:30), there are three key principles realistic mathematics education (RME), namely: (1) guided reinvention and progressive mathematization, (2) didactical phenomenology and (3) self-developed models.

1. Guided reinvention and progressive mathematization.Rediscovery in social interactions can also be inspired by the informal resolution procedure. Informal strategies useful to reach a more formal procedure. To support the process of getting the procedure varied solutions, is expected to follow the learning through the process of progressive mathematization i.e. horizontal mathematization and vertical mathematization process. Horizontal mathematization resolution is the process of contextual problems in the real world by using mathematical language and symbols, and in their own way. De Lange (Wijaya, 2012:42) Divide the mathematization into two, namely horizontalmathematization and vertical mathematization. Horizontal mathematization with regard to the process of

generalization. Horizontal mathematization process can be accomplished through activities: (1) identification of mathematics in the form of a general context, (2) skematisasi, (3) formulation and visualization problems in a variety of ways, (4) a search order and relationships, and (5) the transfer of real problems into mathematical models. While the vertical mathematization activities can be either (1) the representation of a relationship into a formula or rule, (2) evidentiary order, (3) adjustment and the development of mathematical models, (4) use of mathematical models which vary, (5) Combinations and integrating mathematical models, (6) the formulation of a new mathematical concept, and (7) Wijaya (2012:43). Both the mathematization process is illustrated in Figure 1 below:

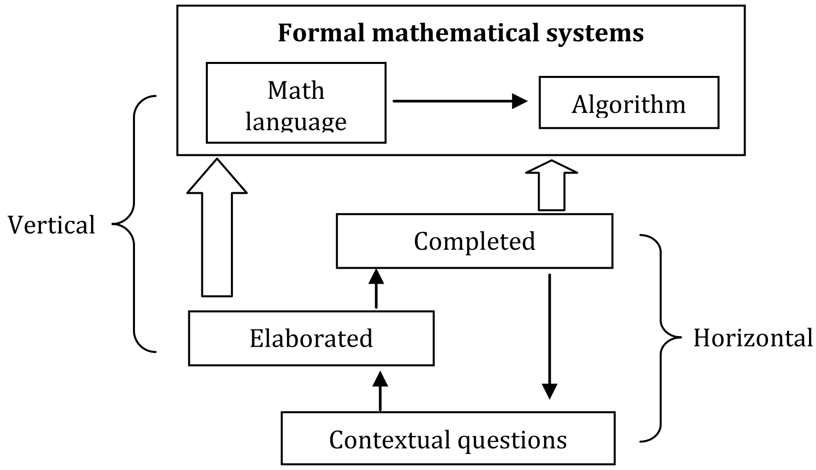

Figure 1 Matematisasi Horizontal and vertical

Thus it can be said that there are two approaches in learning math mathematics maths i.e., horizontal and vertical. Math related activities horizontal students who maintained its position from the world of reality into a world of symbolic math, while the vertical system of mathematics was in it.

2. Phenomenology didactical. The situation in the phenomenology of didactic about topics of mathematics applied to investigate two things, namely to uncover parts of the application and complete the process of progressive mathematization. The phenomenon is the process of didactic activities of students in learning the concepts, principles, or other materials related to the mathematics that derived from contextual issues and have a range of possible solutions.
3. Development of the model itself (self-developed models). This principle is used to bridge the differences between the informal knowledge with formal mathematics. There are four phases where students in learning mathematics that is the real situation, the model of the situation of the real problem, mathematical model, and his formal form (Trefferrs in Musdi, 2012:40). As the third main principle of RME operasionalisasi on top, according to Freudenthal (Gravemeijer, 1994:114-115), RME have five characteristics:
   a. Using contextual issues (The Use of Context). Learning starts with contextual issue of allowing students to use previous experience and knowledge he has directly, not from the formal system. Contextual issues raised as a preliminary matter in learning should correspond to reality or the environment faced by students in the daily is already well understood or easily imagined. According to

Treffers and Goffre (Suherman, 2001:149-150), the problem of kontektual in the RME has four functions, namely: (1) to help students in the creation of mathematical concepts, (2) to form the foundations of mathematics model in favor of the mindset of students math, (3) to make use of reality as the source domain and applications of mathematics, and (4) to train student's ability, especially in applying mathematics in real situations (reality). The reality in question here is the same with contextual.

b. Using the vertical instruments such as models, schemes, diagrams, and symbols (use models, bridging by vertical instrument). The term model deals with situations and mathematical models that are built by the students themselves (self developed models), which is the bridge for students to create their own models of the real situation to the abstract or from informal to formal situations. This means that students create their own model in solving a problem is the link between contextual model real-world situations that are relevant to the student's environment into a mathematical model. So in the process of horizontal mathematization can go to vertical mathematization.
c. Use the contribution of students (student contribution). Students are given the opportunity to develop the existence of various informal strategies can drive on construct a variety of procedures to solve the problem. In other words, a great contribution in the learning process is expected to come from students, instead of the teacher. This means that all the thoughts or opinions of students very note or appreciated.
d. Interactive learning (interactivity). Optimizing the learning process through interaction between students, students with teachers, and students with facilities and infrastructure is important in RME. The forms of interaction as negotiations, explanation, justification, approval, questions, or reflection is used to achieve a form of informal mathematical knowledge discovered by students. Teachers should provide opportunities to students to communicate their ideas through interactive learning process. Related to other topics (intertwining). Various structures and concepts in mathematics pedagogy, so that linkages or integrating intercultural topics or subject matter need to be explored to support in order to make learning more meaningful. Therefore in the RME integrating math lesson units is essential (vital). With the integration that will make it easier for students to solve the problem. In addition with the integration in the learning, learning time is becoming more efficient. This can be seen through the contextual problem is given.

Based on the above description, the student first exposed to problems in everyday life. Then the teacher leads the students in developing the necessary compliance with the given problem, so that students can construct their own knowledge. Students are given the freedom to integrate with each other, including teachers and integrate with existing learning media. Thus, it is expected that large contributions from students.

Some approaches to excellence RME (Pithaloka, 2011:24) that is as follows:

1. Students build their own knowledge so that it is not easy to forget the knowledge he will have

2. Be able to make learning more meaningful and short, since learning starts from contextual issues, so that the students do not get tired to learn
3. Give freedom to the students to develop problem-solving strategies, so hopefully can get varied strategy
4. Can motivate students to learn
5. Foster cooperation in the Group
6. Make the students use its own way different from others in solving problems
7. Train students ' courage having to explain the answer

In addition, some weakness of the approach to RME as follows:

1. Because it's already accustomed to being given information in advance, then the student is still a difficulty in finding the answer
2. Takes a long time especially foe students weak
3. Students are clever sometimes impatient to await his friend who haven't finished
4. Need props that correspond to the learning situation when it

Ability of problem solving is the main results should be from a process of learning mathematics or in other words the problem solving is an integral part of all math learning. Mathematical problem solving is the process that uses the power and benefit of mathematics in solving problems, which is also the method of discovery solutions include the stages of problem solving. The existence of a series of activities performed students in problem solving in finding ideas and idea, surely will give benefits to students. Problem-solving benefits according to Fauzan (2012) in module math evaluation include: (1) students will learn that there are many ways to solve a problem (divergent thinking) and there is more than one solution might from a reserved, (2) students are trained to perform exploration, thinking and bernalar comprehensive, logically, (3) develop the ability to communicate, to form social values through group work, (4) students will be actively involved in the pembelejaran and will more often posited ideas (5) students have more opportunities to use and demonstrate Mathematics knowledge and skills they have, (6) the confidence of students in learning mathematics will increase, (7) provides an opportunity to develop reasoning, and (8) students will gain a rich learning experience, so the atmosphere of the class more enjoyable.

Cognitive research on the last twenty years have produced a different problem solving model. In 1983, Mayer (in Sutarto, 2009:59) distinguish three characterized the resolution as follows:

1. Solving the problem is cognitive activity but abstracted in the behaviour or conduct of
2. Troubleshooting generating behavior that ushered in the completion
3. Problem solving is a process that includes manipulation of prior knowledge of operation.

Problem solving stimulate motivation against intellectual progress, creativity and mental behavior aimed at creating a better structure of his knowledge. As a result, the problem of developing the curiosity and spirit of research indicates the usefulness of the subject taught by solving concrete problems. " (Curtains inCăprioară D, 2015:1860).

According to the NCTM (1989:209) indicator of the ability of problem solving in learning mathematics are: (1) formulating the problem, (2) use a variety of strategies to solve the problem, (3) solve problems, (4) investigate and interpret the results, and (5) the generalized solution. The same thing expressed by Sumarno (2003:23), indicators of such ability of problem solving as follows:

1. Identify the elements that are known, asked, and the adequacy of the required elements
2. Formulate mathematical problems or devise mathematical models
3. Implement a strategy to resolve the various problems (a type and a new problem) within or outside of mathematics
4. Explain or interpret the results according to the origin of the problem
5. Using mathematics in meaningful

From some of the above indicators, as for who becomes the indicator that shows the ability of problem solving in this research include:

1. Understand the problem
2. Prepare a settlement plan
3. Carrying out settlement
4. Summing up the answers

In order to make an assessment of the student's problem solving capabilities can be done as best as possible, it is not only an indicator of mathematical problem solving ability are required but also need a scoring rubric. Scoring rubric for mathematical problem solving capability can be seen in table 1 below:

Table 1. Rubric Scoring Ability Of Problem Solving

Score	Indicators/student response			
	Understand The Problem	**Step-by-step Solution**	**Implement The Solution**	**Summing Up The Answers**
0	Do not know and can not be detailing the elements contained in the problem	There is no plan in solution	There is no carry out settlement	No conclusion
1	Less know and detailing the elements contained in the issues discussed	There is a settlement plan but does not correspond to the problem	Already implement the solution not appropriate solution plans as well as the breathtaking result is not correct	There is kesimoulan but it doesn't match the original problem
2	Knowing the elements are there but not clearly detailing	There is a plan but lacking in accordance with settlement problems	Already carry out settlement in accordance with the settlement plan but the result is not true	There are conclusions da in accordance with the origin of the problem
3	Find out and detailing the elements contained in the problem clearly	There are plans of penyelesaiaannya and in accordance with the problem	Already implement the solution in accordance with the settlement plan and the correct results	There are conclusions and in accordance with the origin of the problem
	Max score = 3	Max score = 3	Max score = 3	Max score = 3

The application of mathematics to solve problems in the real world, called mathematical modeling can be understood as a complex process containing several stages including: understanding the situations such as learning, the development of a mathematical model that describes the core of significant elements and relationships involved in that situation, the application of the mathematical model to solve the problem, a contextual interpretation of the results provided by the model applied (Crahay in Căprioară D , 2015:1862).

Mathematical problem solving is a very important capability that must be mastered in order to afford students apply the concepts and use of skills in a variety of new situations. According to Nesher et al (Bae Seh 2015:2, Y), solve problems in mathematics often refers to the ability to infer new information from a specific data.According to Polya (Suherman, 2003:91), there are four steps in the finish problem-solving, namely:

1. Understand problems, concerns what is known of da are asked
2. Compile settlement plan, which can be realized by write the mathematical sentence
3. Implementing the settlement, after the students collect data that there are then the students carry out appropriate strategies for getting results
4. Looking back, which includes proving that answer is right and concluded the results answer

The troubleshooting steps above can be illustrated as shown in Figure 2. Steps in resolving the problem solving Polya described more details will be explained through the steps according to Fauzan (2012) in mathematical learning evaluation module. These steps is to understand the problem, interpreting issues, visualize relationships between sub problems, makes allegations of solutions to problems while predicting the answer and counting in arithmetic and compare the results with the predictions.

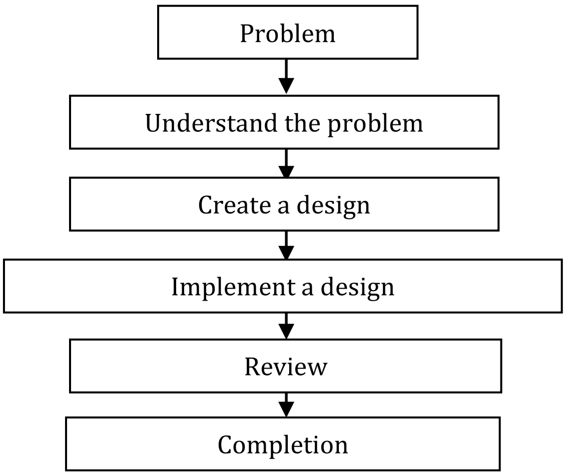

Figure 2. Stages Of Problem Solving According To Polya

Mathematical communication is a very important part of mathematics. Communication is a way of sharing ideas and clarifying comprehension. Through communicationide can be mirrored, improved, discussed, and developed. Baroody (Aufa M, 2016:323) says there are at least two important reasons why the mathematics of communication needs to be cultivated among students, namely: (1), mathematics as a language, (2) learning mathematics as a social activity. Thus, the activities of mathematical communication and the means of social good thinking ability to get recommendations by experts in mathematics education to continuously cultivated and improved between students.

According to the National Center Teaching Mathematics (NCTM, 1996; Broody, 1993; Miriam, et al, 2000) mathematical communication is:

1. Communication of mathematical ideas exploited in variety of perspectives, helping to sharpen the student's way of thinking and sharpen students ' ability in seeing a variety of mathematical material linkages;
2. Communication is a tool "to measure" the growth of understanding; understanding of and reflect on math students;
3. Through communication, students can organize and consolidate their mathematical thinking;
4. Communication between students in learning mathematics is crucial to: pengkonstruksian mathematical knowledge, problem-solving, development and improvement of reasoning, fostering confidence, as well as the improvement of social skills.
5. "Writing and talking" can become very meaningful (powerful) to form an inclusive mathematics community.

According to the Greenes and Schulman (1996:159) mathematical communication is the ability to:

1. Mathematical ideas Expressed through speech, writing, demonstrations and paint his visually in different types
2. Understand, interpret, and evaluate ideas that are presented in writing, orally, or in visual form
3. Construct, interpret, and connecting diverse representations of ideas and their relationship.

According to sullivan & Mousley (Ansari B, 2003:17) mathematical communication not just proclaimed through writing but more broadly i.e. students ' ability in terms of speaking, explained, described, heard, ask, mengklarifikasikan, in collaboration (sharing), writing and finally report what has been learned. This is in accordance with the opinion of Frege (Constanta O & O, Lucian 2012:69) bahwakeberhasilan or communication failure is the problem of the relationship between the speaker and the listener fill minds. Research on effective communication mainly focuses on the process-oriented approach where the focus is on the message transfer, coding and analysis.

Owens (Kabael T, 2012:810) questioned the reasons why students become reluctant when they reach higher grades while they are eager to learn math at early school. Owens emphasized that teachers need to know where in the curriculum to introduce vocabulary and how to make the connection with the knowledge of students to support the use of appropriate vocabulary in math class. It becomes one of the aspects of the problem on the ability of mathematical komunakasi students.Ability of mathematical communication of students of class VIII SMP Negeri in South Nias Regency seen from five aspects of communication according to Baroody (Ansari: 2003) i.e. representing, hearing, reading, discussion and writing still do not meet the indicators that will be achieved.

To measure the mathematical communication indicators according to the NCTM already reflect the ability of mathematical communication of students in more detail again consecrated in Depdiknas (2004). The indicator that shows the ability of mathematical communication students are:

1. The ability to present oral math statements, written, pictures and diagrams

2. The ability ask the alleged
3. Mathematical manipulation capability
4. The capability of compiling evidence, giving reasons, to the truth solutions
5. The ability of drawing conclusions
6. Check the validity of an argument
7. Find a pattern or trait in making generalization

From the explanation above, seen that the ability of mathematical communication occurs if active learning students ride the oral or written. Ability of mathematical communication students can be developed if students are able to connect the real objects, pictures, diagrams and the events of daily life into the ideas and symbols of mathematics. This is in accordance with the principles of the approach to RME.

Based on the above indicators related ability of mathematical communication presented by the NCTM, not all used in this research. The indicators used are: (1) to draw the situation problem and solution of the problem stated in the form of pictures, (2) perform the manipulation of mathematics, (3) draw conclusions, and (4) use of mathematical language and symbols correctly. Based on indicators presented above, ability of mathematical communication scoring rubric can be seen in table 2 below:

Table 2 Ability of mathematical communication Scoring Rubric

The scale of the	Student Response		
	Linking the real objects, images, and diagrams into mathematical ideas	**Explain the situation and relation of mathematics orally or in writing with real objects, images, graphs and algebra**	**Expressed in the language of everyday events or mathematical symbols**
0	No answer	No answer	No answer
1	There is an answer, but it is less precise in connecting real objects, pictures and diagrams into mathematical ideas	The answer is no, but less precisely explain the situation, and the relation of mathematics orally or in writing with real objects, images, graphs and algebra	The answer is no, but less precise language in everyday events declared or mathematical symbols
2	Can connect to real objects, images, and diagrams into mathematical ideas precisely but wrong answer	Can explain the situation, and the relation of mathematics orally or in writing with real objects, images, graphs and algebra with right but wrong answer	Can be expressed in the language of everyday events or mathematical symbols correctly, but the wrong answer
3	Can connect to real objects, images, and diagrams into the idea of mathematics but there is a little mistake	Can explain the situation, and the relation of mathematics orally or in writing with real objects pictures, graphics or algebra but there is a bit of a wrong answer	Can be expressed in the language of everyday events or mathematical symbols correctly, but there is a bit of a wrong answer
4	The answer is true, being able to connect the real objects, pictures and diagrams into mathematical ideas	The correct answer, able to explain ideas, situations, and mathematical relationships, oral or writing, with real objects, images, graphs and algebra	The correct answer is able to declare the event a day day in languages or mathematical symbols

Uno (2010:23) explains, the term motivation comes from the word meaning a motive power found in the individual, which causes the individual to act or do. Motive cannot be observed directly but can be interpreted in the vagaries of the Act, in the form of stimulus, encouragement or the emergence of a certain behaviour. Motives and learning are the two things that influence each other. The motivation of learning can arise due to intrinsic factors, such as the desire and wishes success and boost learning needs, hopes and ideals. According to Sardiman (2003:75), the motivation of learning can be defined as the overall propulsion power within the student learning activities that give rise, ensuring continuity of learning activities that provide direction on learning activities, so that the desired goals by the subject of the study it can be achieved. Advanced Higgins and Kruglanski (Pintrich, 2003:668) mentions a number of other potential basic needs or desires that may play a role in motivating students, but also noted the importance of developing criteria for determining what defines basic needs or wants. This means that in learning, if material or knowledge gained as the basic needs then through motivation that is inside the students will bring up new potentials.

According to Mc. Donald (Hamalik o., 2005:158) "motivation is energychange within the person characterized by affective arousal and anticipatory goal reaction," meaning that the motivation is the change in energy (private) someone who is characterized by the onset of feelings and reactions to achieve the goal. Thus students are able to take responsibility for learning and engage in activities which allow for setting himself (María D, 2014:43).

The learning motivation of students can be measured using instruments question form. As for indicators of motivation in students learning composing grating now learning motivation based on the characteristics of students who are motivated according to Sardiman (2003:83), which are:

1. Persevering in the face of a mathematical task. Students will gain a good learning results if students have always been diligent in doing the tasks given teacher. It can be seen from the spirit of learning, make the task and fear of penalty from the teacher if it is not working on the task
2. Resilient facing difficulty in math lessons. If students have difficulty in solving the problem and less understanding of the materials, the business they do is direct: no despair, keep trying to find an answer, ask a teacher, ask friends and looking for other sources of mathematics books.
3. Shows interest in an assortment of problems in mathematics. If students have a strong interest to learn maths then they will: direct the mind, energy and time to learn, not learning because the instruction or coercion of another person, will feeling happy and excited in learning
4. Prefer to work independently. Traits of students who prefer to work independently are: likes to complete the task on their own and learn or understand the lessons also prefer to own
5. Quickly bored on a math assignment routine. Students who are motivated more breathtaking if: the teacher gives a different task issue and teachers provide different levels of difficulty
6. Can maintain his opinion
7. Happy searching and solving problems of mathematics, namely as solve problems existing in the book though not told the teacher, solve problems in other books of the same material and discussion of love to make a matter itself and finish it.

Of the seven indicators above, indicator 1 and 2 show the motivation of students in the face of adversity. While the indicator is 3 to 7 shows the motivation of students in learning.

The study was based on results of research that has been done by previous researchers include:

1. Sadiana Lase/1204220 (2014) with the title of the research "the influence of Realistic mathematics education Approach Toward the understanding of Mathematical concepts and communication skills of students of class VIII SMP Negeri Subdistrict Lahewa North Nias". As for that being the results of the research are: Understanding the concept of ability of mathematical communication and capable students early high, medium and low approach using PMR, better understanding of concepts and ability of mathematical communication-capable students early high, medium and low by using conventional approaches
2. Riza Aptafia/1203738 with the title of the study: "the effect of contextual learning against the ability of problem solving and mathematical communication grade VIII SMP Negeri in the shadow Year Lessons 2013/2014". With the results of research: the ability of problem solving and mathematical communication learning by learning from both the greater ability of the contextual problem-solving and mathematical communication through conventional learning.
3. Susriani/19638 (2012), with the title of the study: "improvement of Ability of mathematical communication, problem solving, and activity of Students through Realistic Mathematics Education (RME) in class X_1 SMA Negeri 4 Soweto". With the results of the study: there is an increased ability of mathematical communication from cycle to cycle I II i.e. 42.8% primarily on indicators to understand or the concept and the principle against reserved in full. Thus can disimpilkan learning approach that RME can enhance communication skills, problem solving, math and activity of students in class X_1 SMA Negeri 4 Pekanbaru

SUMMARY AND ADVICE

RME is a math-oriented learning approach on the process on mathematicsin the real world, which is often ecperienced in everyday life. The approach of RME is suitable in learning mathematics especially for shildren equal SMP. This helps children solve problems such as problem solving and communication strings by tying it into the environment or real life. In addition to increase the learning motivation of students.

Based on the study of literature has been done then the author suggests:

1. For teachers of mathematics subjects, as a material consideration in planning process of learning by using learning approaches to increase RME the ability of problem solving and mathematical communication in terms of the learning motivation of students.
2. For other researchers, as a reference in the conduct of research relevant to this research.

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THE IMPROVEMENT THE ABILITY TO PROBLEM SOLVING OF MATHEMATICS TO THE STUDENTS BY CORE MODEL (*CONNECTING, ORGANIZING, REFLECTING, AND EXTENDING*).

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Abstract

This study aims to discuss an alternative theory that is suitable to improve the problem solving ability of students at the level of junior high is still low. The low problem-solving ability is caused by the lesson that teachers use less to train the students desire in solving math problems. In line with the current 2013 curriculum where students are required to be active in learning, then one model that can increase student activity is the CORE model (Connecting, Organizing, Reflecting, and Extending). Connecting is the stage where students are invited to connect new knowledge to be learned with prior knowledge by giving students questions to develop student ideas about the material to be delivered. Next organizing is when students are expected to organize their knowledge to solve the problems given by the teacher. At the Reflecting stage students are expected to re-explain the knowledge they have acquired. And at the Extending stage students can expand their learned knowledge and then apply it in further problems.

Keyword: *CORE Model, Problem Solving Ability*

PRELIMINARY

Learning is a two-way interaction between teacher and student as well as theory with practice. Learning in schools has certain goals set in the curriculum. In achieving these objectives required support facilities. This is in line with Hamalik's opinion (1999: 57) which states that "Learning is a combination that is composed of human elements, materials, facilities, equipment, and procedures that affect each other in achieving learning goals". So in learning, which is required not only teachers and students, but also how to make the learning process work well. Therefore, the materials, facilities, or strategies of teachers in teaching also need to be considered.

Mathematics has a different understanding according to experts. But in essence has the same meaning. According to Suherman (2003: 19) mathematics is the science of logic about the form, order, magnitude and concepts associated with each other. This is reinforced by Soedjaji (2000: 11), he states that "Mathematics is the knowledge of logical structures". Both experts agree that mathematics is the science of logical thinking about something that has a form or pattern of interconnectedness. So it can be concluded that mathematics is a science that contains concepts related to each other that helps us think logically.

Mathematics learning is an effort to help students to achieve the goals of learning mathematics through teaching and learning process that is held actively, creative, interactive, inspiring, fun, challenging, and motivating students. One of his efforts is by using a suitable teaching-learning strategy. Therefore, teachers should select and use models, strategies, approaches, methods and techniques that engage students actively in learning, both mentally, physically and socially.

Associated with education in the context of learning then the teacher will be confronted with the students. To form students who have a broad and comprehensive knowledge of teachers must create a conducive learning atmosphere and fun, in addition teachers must apply strategies or learning models that can help students to map the material in memory by making the link between the material and draw conclusions on any given material .

In the curriculum 2013 which students are required to take an active role in the learning process. Activities that make students participate actively and reflect on what they learn can be done in the form of discussion. Setyowati (2011) states that "Discussion is an activity that two or more people attend to share ideas and experiences and expand knowledge." Discussion method is a way of teaching by linking topics or problems that trigger discussion participants to try to reach or obtain a decision Or mutually agreed opinions (Nursidik, 2008).

Calfee et al. (Jacob, 2005: 13) proposes a learning model that uses discussion methods to influence the development of knowledge by involving students called the CORE model (Connecting, Organizing, Reflecting, Exending). Harmsen (2005) states that these elements are used to link old information with new information, organize varying materials, reflect on everything students learn and develop the learning environment.

1. Connecting.

Connect language means connecting, connecting, and connecting. Connecting is an activity of connecting old information with new information or between concepts. The old and new information that will be linked to this activity are old and new concepts. At this stage students are invited to connect new concepts to be studied with the old concept they have, by giving students questions, then students are asked to write related things from the question.Katz and Nirula state that with Connecting, a concept can be linked to other concepts in a class discussion, where the concepts to be taught are related to what the students already know. In order to play a role in the discussion, students must remember and use the concepts they possess to connect and construct their ideas.

Connecting is closely related to meaningful learning. According to Ausabel, meaningful learning is the process of linking new information or material with concepts that already exist in a person's cognitive structure. The cognitive structure is interpreted by Ausabel as the facts, concepts and generalizations the learners have learned and remembered. By learning meaningfully, students' memories become strong and learning transfers are easy to achieve. Connection (connection) in relation to mathematics can be interpreted as an internal and external relevance. Internal linkage is the relationship between mathematical concepts that are related to the mathematics itself and the external relationship that is the relationship between mathematical concepts with everyday life.

According to NCTM, if students can connect mathematical ideas, then their understanding will be more profound and lasting. Bruner also argued that in order for students to study mathematics more successfully, students should be given more opportunities to see the links between theorems and theories, the topics and topics, concepts and concepts, as well as between branches of mathematics. Thus, to learn a new mathematical concept, in addition to being influenced by the old concept that has been known to students, past learning experience of the students will also affect the learning process of mathematical concepts. Because, someone will be easier to learn something when learning is based on what has been known to the person. Because, someone will be easier to learn something when learning is based on what has been known to the person.

2. Organizing

Organize language means organizing, organizing, organizing, and organizing. Organizing is the activity of organizing the information obtained. At this stage the students organize the information they acquire such as what concepts are known, what concepts are sought, and the interconnectedness between any concepts found in the Connecting stage to be able to build their own (new concept) knowledge. To be able to organize the information it acquires, each student can exchange opinions within his group by creating concept maps so as to form new knowledge (new concepts) and gain a good understanding.

3. Reflecting

Reflect by language means to describe, imagine, reflect, and reflect. Sagala reveals reflection is a way of thinking backwards about what has been done in terms of learning in the past. Reflecting is an activity to rethink the information already obtained. At this stage students rethink the information they have acquired and understood at the Organizing stage. In the discussion activities, students are given the opportunity to rethink whether the results of the discussion / results of group work at the organizing stage is correct or there are still errors that need to be corrected.

4. Extending

Extend language means extending, delivering, extending, giving, and extending. Extending is a stage where students can expand their knowledge of what has been gained during the learning process takes place. The extension of knowledge must be tailored to the conditions and abilities of the students. The extension of knowledge can be done by using the concept that has been obtained into new situations or different contexts as the application of concepts studied, either from concept to other concepts, other fields of science, or into everyday life. In the discussion activities, students are expected to expand their knowledge by working on questions related to the concepts learned but in new situations or different contexts in groups.

Problem solving is a process done to solve problems, while problems are challenging questions and can not be resolved (solved) in routine procedures that are known to the perpetrator. So the ability to solve the problem is a capability that the learners have in the process to solve a problem. Dikdasmen no. 506 / C / PP / 2004 (Fadjar: 14) describes indicators that indicate problem solving, among others:

a. Shows an understanding of the problem
b. Organize data and select relevant information in troubleshooting
c. Presents math problems in various forms
d. Choose the right approach and problem solving method
e. Develop problem-solving strategies
f. Create and interpret the mathematical model of a problem
g. Solve non-routine problems

Problems in learning mathematics is a question that must be answered or responded to. But not all automated questions will be a problem. A question will be a problem only if the question indicates a challenge that can not be solved by a routine procedure known to the perpetrator.

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. These data sources contain: Mathematical problem solving abilities and CORE Model Theory. These sources are obtained from journals, books, research report articles and internet sites.

RESULTS AND DISCUSSION

Solution is a process done to solve a problem, While the problem is a challenging question and can not be Solved (solved) by routine procedures that are known to the perpetrator. So Problem-solving ability is a capability possessed Learners in the process of solving a problem. In solving the problem of problem-solving abilities should be done with several stages as follows (Fadjar, 2009: 4). Problem solving is a part of teaching and learning strategy that is very important especially in teaching and learning activities of mathematics. This is as stated by Hudojo (2005: 130) states that problem solving has an important function in teaching and learning activities in mathematics.

Connecting is the stage where students are invited to connect new knowledge to be learned with prior knowledge by giving students questions to develop student ideas about the material to be delivered. Next organizing is when students are expected to organize their knowledge to solve the problems given by the teacher. At the Reflecting stage students are expected to re-explain the knowledge they have acquired. And at the Extending stage students can expand their learned knowledge and then apply it in further problems.

CONCLUSIONS AND RECOMMENDATIONS

The main task of the teacher is to teach students, which is to condition the students to learn actively so that their potential (cognitive, affective, and konatif) can develop with maximum. With active learning, through participation in every learning activity, will be trained and formed the competence of the ability of students to do something positive that will ultimately shape the life skill as the provision of life and livelihood. In order for the above to be realized, teachers should know how students learn and master the various ways to membelajarkan students. One of the models that support student activeness in learning is CORE model. This CORE learning model can improve students' problem solving skills with the following problem solving indicator indicators:

1. Connecting can increase the ability to understand the problem. Because students are led to connect old knowledge with new knowledge. So students can understand the problem.
2. Organizing can improve the ability to organize information and select the relevant information in problem solving.
3. Reflecting can improve students' ability to understand the problem, so that students can restate the problem in various forms.
4. Extending can develop problem solving strategies and make interpretation of mathematical models of a problem so that students can solve existing problems.

Based on literature studies that have been done, the authors suggest:

1. For teachers and educators who want to improve students problem solving skills then CORE model is one alternative that can be applied to learners.
2. For the next writer wishing to write about the CORE model it is advisable to examine how to improve students' mathematical abilities by using CORE models at other levels or on other mathematical skills.

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DEVELOPMENT OF MATHEMATICS LESSON EQUIPMENTBASED ON PROBLEM-BASED LEARNING TO IMPROVE MATHEMATICALPROBLEM SOLVING SKILLS OF EIGHT GRADE STUDENTS OF JUNIOR HIGH SCHOOL

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Abstract

Problem solving is a very important skill in mathematics learning. Problem solving skills are used in learning and solving problems. In fact, the problem solving skills of students is still low. Students should get the opportunity to develop his skills in problem solving. One of the efforts to improve the problem solving skills of students is to develop mathematics lesson equipment based on problem-based learning (PBL). The purpose of this development effort is to produce mathematics lesson equipment based on PBL are valid, practical and effective.This development research uses a Plomp model consisting of three phases namely: preliminary, prototyping, and assessment. Subjects were students of class VIII SMPN 25 Padang. The results of validity of the data analysis showed that mathematics lesson equipment based on PBL has fulfilled valid criteria in terms of content and construct. The lesson equipment have been consider as practical in terms of feasibility, convenience, and time because the lesson equipment can be applied in mathematics learning activities. The lesson equipment has also been effective since they can enhance the problem solving skills. Based on these results, it can be concluded that the mathematics lesson equipment based on PBL which were conducted to students of class VIII in the first semester was valid, practical, and effective.

Keywords: *problem based learning, lesson equipment, problem solving skills, plomp model*

INTRODUCTION

Mathematics is a universal science which has an important role in a variety of disciplines underlie the development of modern technology, social issue, economics, science, and promote human thought. The contribution of mathematics can be seen from the simple thing like using numbers as quantifiers until usage in solving complex problems. The purposes of mathematics learning given at school level are as follow; students have critical thinking skills, logic, creativity, problem solving skills and the ability to convey ideas and familiarize themselves with mathematics; understand mathematical concepts, explain the link among the concepts and apply them flexibly, accurately, efficiently and appropriately in problem solving; develop an attitude which appreciates the usage of mathematics in life, such as having curiosity, attention and interest in learning mathematics itself, as well as being tenacious and confidence to solve problems in daily life or in the real world [1], [2].

The implementation of educational purposes needs a kind of learning which can help students to be trained in dealing with any problems related to the real world issues. Considering the importance of math learning and the objectives of learning the subject, then the ability to think can be developed maximally in the process of learning mathematics at schools. The current way of learning mathematics at school still does not provide opportunities for students to develop the ability to think.

One of the indicators which shows the quality of education in Indonesia tends to be low is the result of the International research of learners 'achievements' in the POM (Project Operation Manual) BERMUTU program (Better Education Through Reformed Management and Universal Teacher Upgrading), [1]. Based on the research conducted by Progress in International Reading Literacy Study (PIRLS), an International study in reading on children around the world sponsored by The International Association for the Evaluation Achievement in 2011, showed that the average reading ability of Indonesian children are at 42th out of 45 participating countries. Indonesia gained a score of 428 on the international average score is 500. It means that the reading ability of Indonesian children is still relatively low. Based on the results of studies conducted on students grade VIII Junior High School by Trends International Mathematics and Science Study (TIMSS) which organized by the International Association for the Evaluation of Educational Achievement (IEA) in 2011 in case of the mathematical ability, they predicated Indonesia on 38th of the 42 participating countries. Indonesia earned an achievement score of 386 on the International average score is 500. From a study conducted by the Programme of International Student Assessment (PISA) which organized by the Organisation for Economic Cooperation and Development (OECD) or the organization for economic cooperation and development in 2012. From the result of study conducted by PISA, it said that Indonesia is still not able to show great achievements in the areas of reading, science and mathematics. Indonesia was only reached 64th rank out of 65 participating countries in the field of mathematics. Results of the International studies have shown that reading ability and math skills of the students in Indonesia are alarming.

Teaching material in the education system is one tool that is very important in determining the success of learning. By the availability of interesting teaching materials, hopefully it can increase the interest and motivation of students to read a book. Reading frequently will cause them being faster to understand the intent which is asked to them and increase their accuracy in doing the tasks. International scale test results can be used as illustration of mathematical ability of students on a national scale. A test on the ability of students nationally can be measured through a national exam. National exam is the standard evaluation system of primary and secondary education nationally and the equal quality of education levels among regions conducted by the Educational Assessment Centre. In junior high school, the standards of passing grade from year to year are increased, such as, in 2015 a passing grade is at least 5.50 for each subject, and the average of all national exam subjects is at least 5.50, and the national exam will no longer be the sole determinant of graduation for the students. Since school exam also determines the graduation with a ratio of 50:50.

Subject which causes students cannot pass the standard of passing grade in national exam is mathematics. The lowest average grade of students at national exam in 2015 was on math. Math in national exam averagely decreased from 61.00 in the previous year to 56.27. This math score averagely showed unsatisfactory results, when it is compared with the minimum completeness criteria. Many grades of students were under the minimum completeness criteria that should be 80. It was probably because their mathematical ability was still low.

The learning process at schools currently cannot increase their ability. The learning process is still centered on the teacher so that students are less concerned with learning. There are still many teachers at school who do not fully carry out what should be done to develop the ability of learners. More students mostly engage in activities that are not related to mathematics in the learning process. Therefore, there should be improvement in the learning process through lesson equipment.

Based on observations of some junior high schools in Padang, that were in SMP 15, SMP Sabbihisma and SMP 25 in May 2015, it was found that the lesson equipmentwas still not able to create active students. It could be seen from the lesson plan (RPP) used by the teachers. Lesson plan (RPP) used still did not provide strategies that actively engage them. The ways of learning which had been created were about routine activities, namely: students are given the concept, the example of tasks related to the concept, and they are asked to do exercises that exist in printed books. If this is done constantly then they might feel tired and less motivated during the learning process.

Based on interviews with some of the junior high school teachers in Padang, it was obtained that the teachers had not designed lesson plan (RPP) which is oriented students and they had not used their own students worksheet (LKPD). LKPD used was only as additional exercises for the students. In the learning process, teachers had not planned a process that could make them active in learning. In explaining the lesson, the teacher only goes straight to the concept of the topic and shows the examples of questions. This way of learning makes students being passive in learning. There were students who asked the teacher to re-explain the concept taught previously when they did exercises and some asked about the results of the counting. However, most students who sat at the back were busy with their own business.

During the observation, students at grade VII answered two questions. From the answer sheets, there were found around 60% of students' wrong answer on question number 1 and about 75% of students' wrong answer on question number 2. The questions given to students were as follows:

1. The surface of a rectangular pool has a size of 20 m x 8 m. Around the pool, there is a path with a width of 2 m which rectangular tile with a size of 20 cm will be assembled. How many tiles are used?
2. Mr. Suto has a rectangular garden with a size of 15 m x 30 m. There will be a fence as high as 1 m created around the garden. If each meter takes 85 pieces of brick, how many bricks are needed to build a fence?

From student's answer sheets, it can be seen that most of the students still cannot understand the ideas of the questions. This situation is in line with the students' difficulties in understanding questions presented in a story. They are really difficult to solve and sketch it, and they are also difficult to interpret the questions in the form of mathematics. Many students are confused in doing the task, so that they answered wrongly as it is not as expected. In addition, most of them answered that question with a similar error. It proves that they do not understand and are not confident with their own answers. They prefered to cheat on their friends' answers rather than trying to find the answers themselves. Lack understanding of concepts in mathematics from students and their difficulties in doing the tasks might be because teachers have not planned their teaching plan maximally yet which is to encourage students to think and engage them actively.

Components of lesson plans which hold an important role is teaching materials. Teachers should be able to choose teaching materials from a variety of learning resources and organize them into teaching materials, so that the standard of competency (SK) and the Basic Competency (KD) could be achieved well. Presentation of teaching materials should be in accordance with the learning model that has been in the lesson plan. The guidances used by the students to understand the learning information acquisition are one of them arranged in the form of Students Worksheet (LKPD). LKPD contains instructions for students to undertake activities clearly. LKPD drafting is done by considering the characteristics, materials and cognitive skills of the students.

One of teaching materials which could enrich student's knowledge and could be as resources for them is LKPD. LKPD is additional teaching materials that can be used by teachers as a means to enhance students' skill in solving the problem and as additional tasks for the students. Based on the observations at LKPD, it could be seen that there has been no LKPD that guide students to meet the concept of learning through solving everyday problems. The current use of LKPD is more likely to lead them memorizing formulas rather than constructing their own knowledge to get the formula and understanding of the subjects. It causes the concepts and principles of mathematics will be easily forgotten by them and characters of logical thinking, critic, honesty, hard working, curiousity, independence and confidence do not develop on them optimally. Therefore, it takes LKPD which directs students to find a concept and principle so that they can construct their own knowledge.

The learning process which is undertaken by teachers should be able to lead active students in learning. The learning process should be centered on learners who may be assisted by the availability of LKPD. LKPD is additional teaching materials that can be used by teachers as a means to add more activities for students in finding mathematical concepts. Students were only accustomed to get any knowledge from teachers. It can lead the students always depends on the teacher. Therefore, teachers must prepare lesson plans that can make their students more active and participate using their ability to learn.

PBL based learning is a kind of learning undertaken to train students in critical thinking and to be trained in solving problems. Lesson equipment based on PBL is expected to open up the minds, to develop ideas, as well as to improve the creativity to think of the students. PBL based learning can accommodate students' knowledge in learning and improve their ability in mathematical problem solving of the problems faced by them in their daily lives. A problem-based learning strategy is a learning strategy which confronts the students on practical issues as a foothold in learning or in other words, they learn something through the issues[3]. Mathematics learning with the application of problem-based learning model proves its successfulness and its quality because it gives higher results of students' achievements compared to conventional approaches[4].

Lesson equipment based on PBL does not only help students to understand the concepts, but it also helps students to understand the application of the material into everyday problems. Lesson based on PBL can "enhance the learning activities of students, help them how to transfer their knowledge to understand the problems in the real world and encourage them to do their self-evaluation toward both the results and the learning process"[5],[6], [7]. Through lesson based on PBL, students think to solve problems, find ideas and make decisions. They will understand more because they engage directly by being active in fostering new knowledge, so that they will remember longer all the concepts and principles. "A kind of learning which is oriented on solving problems such as problem-based learning is an effective learning to enhance the potential of the students"[8], [9].

In the process of learning, there was a change from students' behaviour to be positive. Changes in behavior include aspects of knowledge, understanding, skills and values. "The learning process is a physical or mental activity that takes place in an active interaction with the environment that results a change of knowledge, understanding, skills and values of attitude. The change is a constant reactive and permanent"[10]. It can be concluded that in order to overcome these problems, mathematics learning should be flexible, various and meet the standards.

Based on the description of the problem, a research was conducted in order to produce mathematics lesson equipment based on PBL at grade VIII in odd semester that met the criteria of validity, the practicality and effectiveness. The effectiveness of the equipment was seen from the problem solving skills of the students. Indicators in problem solving used here were as follow: (1) Identify the elements that are known, and questioned the adequacy of the required elements, (2) Formulate a mathematical problem, (3) Implement the strategy to resolve the problem and (4) Re-examine the results which were obtained.

RESEARCH METHODS

This research was a development study using Plomp models, ranging from the initial preliminary research, development phase or prototyping stage and assessment stage[11]. To obtain the valid lesson equipment based on PBL, the preliminary research was carried out. Based on the analysis in the preliminary research, the lesson equipment based on PBL was designed. Ppreliminary research consisted of a needs analysis, curriculum analysis, analysis of learners and analysis of concepts. In the development or prototyping stage, lesson equipment based on PBL was designed. In the prototyping stage, the formative evaluation was done. The development phase or prototyping stage consisted of prototype 1, i.e self-evaluation and the expert review; prototype 2, i.e the evaluation of one-on-one; prototype 3, i.e the evaluation of small groups, and prototype 4 which was the result. Lesson equipment based on PBL which have been designed was self-evaluation and validated by expert review. Validation of this lesson equipment was done by three Mathematics professors, one professor from Education Technology and another professor from Indonesian. Once the lesson equipment based on PBL is validated, the evaluation of one-to-one, the evaluation of small groups and field test were done to see the practicality. In the assessment stage, a field test at class VIII SMPN 25 Padang was conducted to look at the practicalities and effectiveness. The data were collected through the validation sheets, questionnaire sheets of teachers' and students' responses, observation sheets of the enforceability of RPP, the interview sheets and the results of problem solving skill tests of the students.

RESULTS AND DISCUSSION

1. Preliminary Investigation Phase

In the initial investigation phase, firstly the researcher did the needs analysis, the curriculum analysis, the analysis of learners and the concepts analysis. The description of the initial investigation phase could be as follow:

a. Need Analysis

At this stage, the researcher gathered information on issues related to the problems faced by students in learning mathematics. Gathering information activity was carried out by interviewing some of the students and teachers. Besides, the researcher also did an observation toward the lesson equipment used by the teachers and so the teaching and learning activities.

As a result from the need analysis, it was found that the lesson equipment of mathematics was not optimally used. The results of interviews with some mathematics teachers, there was found that they have implemented a variety of mathematical methods in the learning process but it has not run optimally. Lesson plan (RPP) used by teachers has not facilitated students to improve their ability. Students Worksheet (LKPD) used were more likely presenting the concepts and principles directly without explaining how to get it so that students were not accustomed to use thinking skills to solve a problem scientifically. Thus, the school needs valid, practical, and effective mathematics lesson equipment.

b. Curriculum Analysis

The process of analyzing the curriculum was aimed to determine whether material (SK and KD) about SPLDV and the theorem of Pythagoras which is stated on the curriculum is in accordance with the expected competencies, whether the material is sufficient to achieve the purpose of learning, and whether the material has been ordered well. The curriculum analysis was focused on analyzing the standards of competence (SK) and basic competence (KD) listed on content standards. Analysis curriculum was intended as a guide in the development of mathematics lesson equipment based on PBL for students at grade VIII. The results of the analysis of this curriculum was used as the basis for formulating the indicators of learning achievement in developing the lesson equipment based on PBL for students at grade VIII in first semester.

In order to achieve the good learning indicators, the guidance of teachers is needed and the teaching materials that are used can facilitate the students in order to understand the concepts well. Based on the analysis of SK and KD then the order changing was made. It was done to adjust the level of difficulty and the relationship between concepts. Based on the level of difficulty, completing SPLDV was more difficult than creating a mathematical model of everyday problems associated with SPLDV. Therefore, the researcher slightly altered the order of the teachinga and learning process, so that students know and be able to create a mathematical model of the problems associated with SPLDV before completing SPLDV.

c. Student Analysis

This stage was aimed to determine the quality of each student that can be used as a guidance in designing the learning equipment. The focus of the activities carried on analyzing the students was about how students' characteristics include the level of thinking, the power of abstraction, the inclination to learn, and how the provision of students' skills to use the lesson equipment. The age of students in class VIII ranged between 13-14 years. Piaget from his research stated that in this age range, the cognitive development of students has been already at the stage of formal operations [12]. At the stage of formal operations, children are able to perform reasoning using abstract things.

Results from the analysis of learners were done as a basic foundation of development in designing the lesson equipment from the language level and the level of difficulty of the problem. The first result showed that the students had a high curiosity. Secondly, most of students did not pay attention to the teacher's explanation during the course. Thirdly, they were easy to forget about the concepts that have been studied. Fourth, when they were asked to take notes of the lessons that have been explained, most of them did not do it. They rather drew something which was not related to the lesson on their book. Fifth, students liked the discussion. Sixth, they liked being in a group when they went buying something to the canteen. Lesson equipment based on PBL is a learning that can implement the cognitive phase of students who has started to think scientifically. In the learning process used lesson equipment based on PBL, students learn in groups and do discussion in order to understand the concept, so that these activities can facilitate students who like working in groups and doing discussion. Students who have high curiosity will try to find solutions to the problems with their own ways and discuss it with friends. At the end of the activity, students were asked to make a conclusion toward the material which has been learned.

d. Concept Analysis

Analysis of the concept was aimed to determine the content and subject matter required in the development of lesson equipment by identifying the main concepts taught, detailing and arranging them systematically. The learning material in the first semester is the factorization of algebra tribe, functions, the equation of straight line, SPLDV and the Pythagorean theorem.

2. Development phase or Prototyping

a. Designing lesson equipment

Designing the mathematics lesson equipment based on PBL was based on the analysis of the initial investigation phase. The result of this design would produce prototype 1. The lesson equipment designed here was referred to the learning characteristics of PBL. The following description of the lesson equipment based on PBL.

1) Designing Lesson Plan (RPP)

A lesson plan is designed systematically which contains the writing components of it listed on Permendiknas 41 of 2007 about the standard process for primary and secondary education. In creating the lesson plan, there are some principles that must be counted, namely; The lesson plan is designed based on the individual differences among students, the learning process was designed with a focus on students to encourage their motivation, interests, creativity, initiative, inspiration, independence and enthusiasm for learning. Besides, it is designed to develop their fondness in reading, their reading comprehension and their expression in a variety of different forms of writing, and to provide feedback and follow-up to them. The lesson plan is prepared by paying attention to the link and the integration between SK, KD, learning materials, learning activities, indicators of achievement on competencies, assessment, and learning resources in the integrity of the learning experience. It is also well-prepared by considering the application of information technology and communion in an integrated, systematic and effective ways in accordance with the circumstances. It is prepared for every KD and it can be implemented in one meeting or more. The researcher designed a piece of the lesson plan for each meeting which was adapted with the scheduling system in the education unit.

Core activities in the lesson plan were based on syntax of learning PBL based. PBL learning phase began with the orientation of students to the problems. In this stage, they faced a problem that was associated with a concept that would be studied. The second phase of the PBL learning was organizing students to learn. At this stage, the students tried to understand and examine the problems so that they could understand the concepts which has been learned. The third phase of PBL based learning is guiding the investigation of individuals and groups. At this stage, students are trained to put out ideas in the discussion and respect the opinions of members in other groups. They are invited to solve problems about everyday life related to SPLDV. Tasks which were given made students understand more the concept of subjects deeply and meaningfully, so that the concepts which have been learned were memorable. The fourth phase was developing and presenting the work. At this stage, the students presented the results of group discussion. The fifth phase was analyzing and evaluating the problem-solving process. At this stage learners responded to the results shown by their friends.

2) Designing LKPD

LKPD based on PBL has several components, namely the title, SK, KD, indicators, learning objectives, LKPD instructions, problems, work steps, and exercise. LKPD has attractive pictures based on a given problem to understand the concept which is being studied. LKPD is designed with various and bright colors. On the bottom of each page at LKPD, there has motivation words that aims to give spirit and to occure awareness for students in order to learn more seriously. LKPD began by presenting the questions or problems that aimed to help them to relate the observed phenomenon with a concept that would be constructed. Further to practice problem-solving ability of students to identify the elements that were known, questioned, and the adequacy of the elements needed, formulate the problem, solve the problem, draw conclusions and recheck the results obtained. LKPD uses simple and communicative language and also based on the level of students communication, so that the presentation of the material in LKPD is well understood. The questions in LKPD were prepared with clear sentences so as to direct the students get the expected response.

b. Prototype 1

Results of designing the lesson equipment at an early stage is called the prototype 1. Furthermore, the equipment was validated to obtain valid equipment. Two steps involved in the validation of the lesson equipment, namely validity construct by doing self evaluation and content validity evaluation by discussing the lessons to 3 experts. Here are the descriptions of the results of prototype validation from lesson equipment that has been designed.

1) Self-evaluation Lesson Equipment

The first activity undertaken after designing the lesson equipment was to examine the equipment by the researcher. Before consulting and discussing it with the experts, formerly a self-evaluation to the lesson equipment that has been designed was conducted. In general, most errors occurred at typing, sentences which were not clear in meaning and the punctuation errors. For example in the lesson plan, an error occurred in the repetition of the word "students can". On the lesson plan, it was written "learners can can". Errors in punctuation were such as, after the punctuation, there was no gap given within one space. In LKPD, shape colors used caused the writing became unclear, it also has been already revised. After self evaluation toward lesson equipment was done, futhermore bthe revision process was done. The revisions were consulted and discussed with expert or competent experts.

2) The Validation Results of Lesson equipment by Experts

The lesson equipment was validated by five validator whom three of them were mathematician professors, one of education technology lecturer and one of Indonesian lecturer. In the lesson plan, the aspects which were observed were the aspect of identity on the lesson plan, indicators of competencies achievement, learning objectives, teaching materials, models, approaches, strategies and learning methods, steps of learning activities, learning resources, assessment, writing language, and benefit of the lesson plan.

During the validation process, there were several revisions suggested by the validators. Based on the advice from validators, there were some points that needed to be improved, namely in terms of writing the acronym of the lesson plan title, the writing time allocation which was not in accordance with the steps of learning activities, and writing learning objectives that have not been arranged as ABCD (audience, behavior, condition, degree). Then on the concluding section of learning, there should be written further learning materials that will be learned by the students. After the revision was done, the validator gave an assessment of the lesson plans which has been designed.

The average results of validation for the lesson plan were in the range of 81% to the range of 100%, that was with very valid criteria. The overall validity of the lesson plan was about 90.23% categorized as very valid. Thus, it can be concluded that the aspects of lesson plan components based PBL were valid.

In LKPD, the aspect observed was dikdatik or presentation, the material aspects and the content, linguistic aspects, and the graph aspects or display. During the validation process, there were several revisions suggested by the validator. After the revision was done, the validator gave an assessment on the LKPD. LKPD validation of dikdatik or presentation aspects as well as the material aspects and contents was done by three mathematics lecturers. The average results of dikdatik aspects validation and the material aspects of the LKPD were in the range of 81% to the range of 100% which were very valid. The results of the validation illustrated the everyday problems presented in LKPD related to the learning objectives and displayed pictures that could help students to understand the concepts. It can be concluded that LKPD has valid from dikdatik aspects and the material aspects.

LKPD validation toward the language aspects was carried out by a lecturer from Indonesian subject and S3 student of UNP. The average results of the validation on the language aspects toward LKPD were in the range of 61% -80% with the criteria as valid enough. The results of the validation illustrated that the use of sentences in LKPD has been in accordance with the rules of good Indonesian. The sentences that were used could engage students to think logically because it has been adapted to the language level of students. It can be concluded that LKPD has been valid from the language aspects. LKPD validation of graph aspects or display was done by a professor of educational technology. The average results of the validation on the graph aspect toward LKPD were in the range of 81% to 100% with the criteria as very valid. It can be concluded that LKPD has valid in the graph aspects or display. The value of LKPD validity overall was about 86.08% categorized as very valid. It can be concluded that LKPD based PBL was valid.

c. Prototype 2

Activities performed on prototype 2 were to test the practicalities of learning equipment. Practicalities test was aimed to determine the extent of the benefits, the ease of its use and the efficiency of time on the use of equipment based on PBL by the students. Evaluation was done by asking the students commented on LKPD that has been designed. LKPD was given to students of SMPN 25 Padang grade VIII.6 – one of a capable student and two others were in low-ability. They were asked to read and do LKPD. One-to-one evaluation was conducted by 7 times of meeting. Activities undertaken were such as observing the instructions which were difficult to understand by learners on LKPD, noting comments, suggestions, sentences which were difficult to understand from the presentation and questions toward LKPD from the students.

After learning used LKPD based PBL was implemented, then interviews were conducted to determine the practicality of LKPD. The results of the analysis from interviews illustrated that the presentation on LKPD was very interesting and helpful for the students in order to understand the material. The use of language in LKPD could be well understood and the pictures on the cover page were removed. The questions contained on LKPD were categorized as in the medium level. Besides, in doing the tasks, most of students were less scrupulous in summing, subtracting, multiplying, and dividing. Based on the analysis of the interviews, the revision was conducted.

Once the revision process of LKPD was complete, the revision of the prototype 2 was done based on the advices from the students. The revised results at prototype 2 were called the prototype 3. Next, the practicality test of LKPD based PBL was done. Practicalities test was aimed to determine the extent of the benefits, the ease of its use and the efficiency of time in using LKPD based PBL by teachers.

d. Prototype 3

Activities performed on the third prototype were to test the practicality of the lesson equipment by evaluating small group. Evaluating the small group was done by practicing the lesson equipment which has been designed at a group of students consisted of nine. The revised result of the prototype 3 was called prototype 4. Evaluation of small group was done among students who had medium and low level of capability at SMPN 25 Padang grade VIII.6. Evaluation of small group was conducted by 7 times of meetings.

Based on interviews conducted to the nine students, it was found that the effectiveness and the efficiency of time needed in doing the tasks on LKPD has been enough. They thought that parts which provided the potential of failure in using LKPD in actual class was on the classroom management that was in managing students in order to have seats based on their each group. To anticipate these conditions, the researcher and teachers worked together in managing the classroom so that students did not spend a long time to sit in their groups. Furthermore, in terms of implementation, students were able to use LKPD easily, although there was still a question arised during their work on LKD.

In terms of presentation on LKPD, it has been interesting by providing problems in daily life, despite initially students found it difficult because they seldom did questions illustrated in a story. However, they seemed enthusiastic to try. They thought that in the design of learning, learning strategy use questions related to everyday life was quite interesting, those questions helped them to solve the problems and to make conclusions. Activities that were used in LKPD were interesting, the presentation of pictures and illustrations on LKPD eased them to understand the concept of the material which was being learned. Students were less accustomed to convey their own opinion, if on the LKPD, there was a command that asked students to convey reasons. Moreover, in solving the problem, they were less careful in completing it.

e. Prototype 4

After the results of the revision on the individuals and small groups evaluation gotten, then it was followed by field test (prototype 4) at grade VIII.7 of SMPN 25 Padang. The field test of the lesson equipment based on PBL in large classes was done as much as 7 meetings. During the testing of a large class, the researcher was assisted by one teacher and one observer. Teachers taught using the lesson equipmentwhich has been designed. The observer was in charge of observing the implementation of lesson equipment based on PBL by using questionnaire sheets of implementation observation.

Data practicalities of lesson equipment based PBL were obtained from a questionnaire of teachers and students and observation of learning implementation. The effectiveness of the leraning equipment was seen from the ability of students in solving the problems.

In the first meeting, the students still were not familiar in writing the lists of the elements that were known in a given problem, and then doing double-check toward the correctness of the answers which has been obtained, and they were not used to write the conclusion of any given problem. They directly wrote the solution of the given problem, without specifying the elements that were known, then double-checked the truth of the answers, and wrote the conclusion from the settlement of the problem.

The development of problem-solving skills of students in the second meeting has begun to change, but students still did not use to write the conclusion of problem solving. In the third meeting until the last meeting, the development of the ability of problem solving on the students has been in accordance with the indicators expected and has increased in every meeting. Indicators of problem solving were as follow: a). Identify the elements that are known, being asked and adequacy of the elements which is needed b). Formulate a math problem, c). Implement strategies to solve problems, and d). Re-examine the results obtained.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of data analysis, it can be concluded that lesson equipmentdesigned based on Problem Based Learning has a valid, practical, and effective use to improve problem-solving abilities of students of grade VIII. Based on the conclusions above, the lesson equipmentbased on Problem Based Learning can be used as a guide for teachers in implementing the learning to improve mathematical ability of the students.

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IMPROVING PROBLEM SOLVING SKILLS OF STUDENT BY USING GUIDED INQUIRY LEARNING AND CONCRETE REPRESENTATIONAL ABSTRACT (ARC) APPROACH

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Abstract

Mathematics is one of the science which is required in human life, as through learning mathematics man trained in order to think critically , logical , systematic , and can solve the problems they have in daily life .National council of teachers of mathematics (NCTM , 2000) formulate some the purpose of learning mathematics. One of them is learn to solve problems (problem solving). Based on the purpose , reflected that the problem solving an important aspect in learning mathematics. Effort to improve problem solving skill by designed a learning more involving interaction students actively and invention on learning so that can dig potential and improve the ability available. One of the learning that is expected to facilitate students in improving the problem solving ability of mathematics is guided inquiry learning with Concrete Representational Abstract (CRA) approach. The research method used is literature study. Based on the study, guided inquiry learning with Concrete Representational Abstract approach (CRA) is expected to develop students' mathematical problem solving skills.

Keywords: *guided inquiry, Concrete Representational Abstract approach, problem solving*

INTRODUCTION

Mathematics is one of the necessary science in human life, because through the learning of human math is trained in order to think critically, logically, systematically, and can solve problems faced in everyday life. Therefore, mathematics is studied at all levels of education from elementary school to university. In addition, mathematics also become one of the graduation of students from elementary school to middle school.

Education Ministerial Regulation No. 22 of 2006 on content standards for elementary and secondary education units generally explains that the subjects of mathematics aims to enable learners to have the following skills: (1) Understanding mathematical concepts, explaining interconnectedness between concepts and applying concepts or algorithms, Flexible, accurate, efficient, and precise, in problem solving; (2) using reasoning in patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements; (3) solve problems that include the ability to understand problems, design mathematical models, model and interpret solutions obtained; (4) communicate ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems. (5) has an attitude of appreciating the usefulness of mathematics in life, which has a curiosity, attention, and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving.

In relation to the objectives of mathematics subjects, NTCM (2000) also emphasizes five process standards that must be achieved by middle school students, namely problem solving, reasoning and proof, communication, connections, and representation. Based on the objectives of the mathematics course and the NCTM standard, the ability to solve mathematical problems is one of the abilities that must be achieved by students in learning mathematics.

With regard to the importance of mathematical problem solving abilities, the PISA study results show that the mathematical ability of Indonesian students is still low. This can be seen from the results of the last PISA 2015. Based on these results the performance of Indonesian students is still relatively low. The average score of achievement of Indonesian students for mathematics is ranked 62 out of 70 countries evaluated with an average score of 386, while the average international score is 490. The rating and average Indonesian score is not much different from the test results And previous PISA surveys in 2012 which are also in the low material mastery group. (University of Surabaya, 2016).

In line with the results of PISA above, research conducted by Aulia Rahmah (2016) also shows that the problem solving ability of students is still low. Of the 32 students given problem solving skills only 12 students were able to complete correctly. In other words only 37.5% of students are complete.

In order to achieve good mathematical problem-solving skills required a proper learning and approach in mathematics learning. One of solution that is supposed to improve mathematical problem solving abilities is guided inquiry model (Ahmad Afandi, vol 8, 2013). Guided inquiry learning will be more effective if accompanied by Concrete Representational Abstract (CRA) approach (Lisa Dwi Afri, 2015).

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. This research contains about the ability of problem solving mathematics, guided inquiry, and Concrete Representational Abstract (CRA) approach.

RESULT AND DISCUSSION

Based on the results of literature studies that have been done, Solving the problem according to Joni in Suharsono cited Wena (2011) is a process of acquiring information that occurs in one direction from the outside into the students, but as a gift of meaning by students to experience through the process of assimilation and accommodation To develop his cognitive abilities. Gagne in Wena (2011) states that problem solving is a process of finding a combination of a number of rules that can be applied in an effort to cope with the new situation.

The process of solving the problem according to Polya (1973) took place with several stages as follows: (1) Understanding problem. In this step the student must be able to understand the problem. (2) Device a plan. In this step students make a plan of completion by linking the data that are known either in the form of calculation, measurement or constructing (drawing) to complete the data that is not yet known. (3) Carry out the plan. In this step the student executes the plan. Implementing the plan is easier than designing the plan, because at this stage the student will execute the previously planned plan in the previous stage. (4) Look Back. In this last step review the solution or test the solutions that have been obtained.

Bell (1981) says that "the inquiry model is the process of investigating and examining a situation in a search information and truth. Inquiry processes are used in science and mathematics to extend and organize knowledge ". The inquiry learning model used in this study adapted the inquiry learning model stage proposed by Bell (1981) as follows: (1) Presenting the problem. (2) Create a settlement procedure and collect information (3) Analyze data and (4) Make a conclusion.

Based on troubleshooting steps and inquiry learning process above is known that the process of inquiry learning and problem-solving process has a relationship that is the same learning process that will produce the same ability indicators. Inquiry process according to Bell (1981) in the stage presents the problem. Problems presented by teachers should be able to encourage students to investigate. In the early stages students are trained to understand the problem by reading the given problem, repeating the problem given in their own language, knowing the data provided. At this stage students are trained to have "understanding problem" skills.

The next is the stage of making a procedure and collect information. Students investigate the known and unknown data of the problem to assist in the preparation of a problem-solving plan. The stage of making the procedure of completing and collecting information is the same as the stage of a plan in the problem-solving process, after the problem is given the students investigate the unknown and unknown data of the problem so that the student has a picture of completion in conducting the investigation.

The third stage of inquiry is to analyze the data, that is, after the students know the known data and the students do not know the data analyzes (the students determine the formula used, create the picture / table / graph) the same stage with "carry out the problem" in the process Problem solving students discussed carrying out all the problem-solving plans that have been made to make a solution conclusion to the given problem.

The last stage of inquiry learning is to make a conclusion that is to make a conclusion, and to test the conformity of the solution that has been made with the actual solution. The stage is the same as the look back stage in the troubleshooting phase.

Guided inquiry learning has several advantages, namely: a) Students can participate actively in the learning presented. B) Grow and simultaneously instill inquiry attitude. C) Support students' problem solving abilities. D) Providing a vehicle for interaction between students, as well as students with teachers, so students are also trained to use good and correct Indonesian. E) The material studied can attain a longer capability level because students are involved in the process of finding it (Widdiharto, 2004). This is evidenced by the increased ability of students' mathematical problem solving. Students who are learning with guided inquiry have better problem-solving abilities than students with conventional learning (Yenny Meidawati, vol.1, 2014).

The Concrete Representational Abstract Approach (CRA) is an intervention for mathematics teaching suggested by research to improve students' mathematical performance with learning disabilities. Witzel (2005) argued that the CRA approach means students are invited to participate in the concrete, representational and abstract stages. At the concrete stage, students are invited to recognize or discover concepts directly through the manipulative visuals of concrete objects, followed by pictorial representation of concrete object manipulation and ending in the third stage of solving math problems indirectly using abstract notation.

The use of a problem-based CRA approach creates a meaningful learning process for students through the problems presented. Mathematical problem solving skills of students who gain learning with a CRA approach are better than students who have received conventional learning. This is because the problem-based CRA approach presents an active classroom atmosphere, as all students will be involved in learning (Reni Pebriani, 2016).

From the above explanation and literature study it can be expected that guided inquiry learning and Concrete Representational Abstract approach (CRA) can develop and improve students' math problem solving skills.

CONCLUSION

From the description above it is known that inquiry learning has the linkage of indicators with problem-solving ability. While the CRA approach can help students in solving a problem. Therefore, it is suspected that guided inquiry learning and Concrete Representational Abstract (CRA) approach can develop and improve students' math problem solving skills. The guided inquiry step consists of (1) formulating the problem, (2) formulating the hypothesis, where the hypothesis is a temporary answer to the question or solution of the problem that can be tested with the data, (3) Collecting data, where the teacher guides the students to determine the steps, Data collection steps using Concrete Representational Abstract (CRA) approach, (4) Data Analysis, and (5) Making Conclusions.

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IMPROVING STUDENTS MATHEMATICAL COMMUNICATION SKILLS USING THE ACE STRATEGY

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Abstract

This study aims to develop students' mathematical communication skills using the ACE strategy. Communication skills are understood as a form of information delivery activity. In communicating math includes the skills or ability to read, write, review and respond to information. Students are actively involved in doing math, thinking of ideas orally and writing, charting, graphics or talking and listening to other students in sharing ideas, strategies and solutions. The ACE (Activities, Class discussion, Exercise) strategy focuses on activities, class discussions and exercises aimed at introducing concepts, proposing and applying the concepts already obtained. ACE provides students the opportunity to be creative, gain intuition, and experience in math. This strategy is to make it easier for students to learn systematically, effectively and efficiently in facing various problems in communicating. After conducting literature studies by citing data from various sources it is suspected that ACE strategy can improve students' mathematical communication ability.

Keywords: *ACE Strategy, Communication Skill*

INTRODUCTION

Mathematics is one of the sciences whose functions and applications are needed for many life issues, including for the development of science and technology (Science and Technology). Given the importance of mathematics in life then the subjects of mathematics are given to all learners starting from elementary school. As contained in the contents standard for mathematics subjects in Permendikbud No. 58 of 2014 stated that mathematics subjects should be given to all learners starting from elementary school, to equip learners with logical, analytical, systematic, critical, innovative and creative thinking , And ability to cooperate. These competencies are needed so that learners can have the ability to acquire, manage, and utilize information to live better in an ever-changing, uncertain, and highly competitive state. So the introduction of mathematics that it has to be steady begins since elementary school.

The purpose of learning mathematics in schools so that learners have adequate mathematical skills, so that the various competencies are expected to be achieved properly and optimally. For that, learning mathematics in schools need to be directed to help learners use their intellectual power in the learning process.

To bring up the necessary mathematical skills tools to explore the beauty of mathematics. NCTM (2000) describes that to be able to understand and use mathematics required mathematical power (mathematical power), Which includes the ability to explore (exploration), put reason logically (reasoning), solve problems not routine (problem solving), Communicating mathematics (communication), connecting ideas within and between mathematics (conection), and other intellectual skills.

Each learning objective of mathematics is the formation of reasoning ability in the learner that is reflected through the ability to think critically, logically, systematically, and have objective, honest, discipline in solving a problem both in the field of mathematics, other fields, or in everyday life.

The role of learning mathematics and mathematics goals is very important in improving communication skills. The ability to communicate becomes one of the conditions that play an important role because it helps in the process of composing the mind, connecting ideas with other ideas so as to fill in the lack of things in the whole network of learners' ideas. Mathematical communication is the ability to communicate ideas with symbols, graphs or diagrams to explain the situation or problem. In the assessment of mathematical communication the assessed aspect is the ability of learners to declare and interpret mathematical ideas orally, in writing, or in demonstrations (Suyitno, 2005).

Communication skills are very important things in the learning activities, but based on the results of literature studies conducted many found that the communication skills of students is still low, one of the results of research conducted by Fitria Pratama Ningsih 2016, from 25 students only 6 students who complete In communication skills, from a complete percentage of 28% completion. It can be seen that the communication ability of students is still low. So many learners are not able to solve problems that exist in mathematics.

The communication ability of learners is low because learners have not been able to explore the ideas and concepts of the problem, so as not to describe good communication. One indicator of communication is to explain the situation ideas and mathematical relations orally or written with real objects, images, graphics and algebra.

So that learning goes well that can encourage learners in using the mindset. So it takes a teacher's creativity in creating learning methods that can improve mathematical communication skills of learners so that the purpose of learning mathematics can be achieved. Therefore, in this literature study the author provides a solution to improve the mathematical communication skills of learners one that can be used by teachers is learning with Activity strategy, Classroom discussion, and Exercise (ACE). ACE learning consists of activity, classroom discussion and exercise, in which learners are actively involved physically and mentally and there are activities that can bring learners to discover their own principles on the material being studied.

ACE learning (activities, classroom discussion, exercise) is an implementation of learning based on APOS theory (action, process, object, schema) developed by researchers in the United States (RUMEC). The learning of ACE includes three steps of learning activities: ACE activities, class discussions and exercises aimed at introducing concepts, proposing and applying the concepts already obtained. This strategy provides the learners to learn systematically, effectively and efficiently in dealing with various teaching materials (Nurlaelah, 2003).

Based on the problems that have been stated above is suspected that ACE strategy can improve students' mathematical communication ability.

RESEARCH METHOD

This study included a type of literature study. Where literature study is the way used to collect data or data sources related to the topics raised in a study. This research is about improving mathematical communication ability and ACE strategy.

RESULTS AND DISCUSSION

Communication is a way of sharing ideas and clarifying understanding, then through communication ideas are reflected, corrected, discussed, and changed. Communication skills need to be intensively presented so that learners are actively involved in learning and eliminate the impression that mathematics is a foreign and frightening lesson. The ability of mathematical communication is also very important because mathematics is basically a language with terms and notations term until the concepts are formed and understood and manipulated by learners. According to Barody (Yonandi, 2010) there are two reasons why mathematical communication is important, namely: (1) mathematics as language, meaning that math is not just a thinking tool. Mathematics helps to find patterns, solve problems, but math is also an invaluable for communicating a variety of ideas, precisely, and succinctly and (2) mathematics is learning as social activity, The meaning is as a social activity in the learning of mathematics, as well as the interaction between learners, teacher communication with learners, teacher communication with learners is an important part in learning mathematics in an effort to guide learners understand the concept or find a solution a problem.

With regard to this mathematical communication, Sumarmo (2003: 24) provides indicators of mathematical communication, namely:

a) Connecting real objects, images and diagrams into mathematical ideas
b) Explain the situation ideas and mathematical relations both orally and in writing with real objects, images, graphs and algebra
c) Stateing everyday events in language or mathematical symbols
d) Listening, discussing and writing about mathematics
e) Read written mathematical presentations and compile relevant statements
f) Creating conjectures, formulating arguments, formulating definitions and generations
g) Explain and make math questions learned.

ACE learning (activities, classroom discussion, exercise) is an implementation of learning based on APOS theory (action, process, object, schema) developed by researchers in the United States (RUMEC). ACE cooperative learning approach is a productive model because learners are actively involved physically and mentally. ACE learning basically embraces constructivism, especially constructivism developed by Vygotsky, social constrructivism. According Dubinsky, E. et al (1994) knowledge and understanding of mathematics that learners are the result of construction and interaction of learners with others in dealing with mathematical problems.

ACE's strategy includes: the activities of learners can reduce abstract concepts to more concrete, ie by exploring examples or not examples related to the concept as well as with the properties of the concept (Asiala et al, 1997). Subsequent activities are learners given the task to form a mental construction that is expected to learners gain experience to find something about the material learned in groups cooperatively. Class discussion activities, learners conduct group discussions to present the findings of new concepts about the material being studied. In this step learners are given the opportunity to exchange information so as to achieve the same understanding of a learned concept. The teacher acts as a facilitator and a motivator in directing the discussion. Learners are expected to express opinions or ask questions based on previously understood concepts. In the exercise stage, learners are given the opportunity to apply the concepts that have been mastered by learners in solving some problems in mathematics. With this activity learners will gain a lot of experience about how the vagaries of the application of concepts in solving a problem.

By applying ACE learning repeatedly, learners better understand the concepts discussed, can develop learning activities of learners to express opinions, ask questions, and conclude so that eventually there is increased activity and learning outcomes (Asiale et al, 2000) . Thus, ACE learning provides opportunities for learners to creativity, gain intuition, and gain experience in math and as a solution to improve students' mathematical communication skills.

CONCLUSION

ACE strategy is a learning method that can improve students' mathematical communication skills. Through the activities of learners can reduce abstract concepts to be more concrete, that is by exploring examples or not examples related to the concept and with the properties of the concept. Classroom discussion activities of learners conduct group discussions to present the findings of new concepts about the material being studied. In the exercise stage, learners are given the opportunity to apply the concepts that have been mastered by learners in solving some problems in mathematics.

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THE DEVELOPMENT OF MATHEMATICS LEARNING INSTRUMENTS BASED ON GUIDED DISCOVERY TO IMPROVEMATHEMATICAL COMMUNICATION ABILITY ON GRADE VIII SMP

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Abstract

Communication ability is a very important skill in mathematics learning. In fact, the problem solving skills of students is still low. There areseveralfactors causingthelow ability. One of themis the unavailability of lessonss equipments whichfacilitatesstudents togrow and developmathematical lesson equipment based on guided discovery. One of the efforts to improve communication ability of students is to develop mathematics lesson equipment based on guided discovery. The purpose of this development reseach is to produce mathematics lesson equipment based on guided discovery which are valid, practical and effective. This development research uses a Plomp model, subjects were students of class VIII SMPN 12 Padang and validation was done by the experts in mathematics, technologi of education and languange. The practicality of the lesson equipment was seen from the results of the practicality questionnaire of the implementation of learning and questionnaire of students and teachers. The effectiveness was analyzed from the results test communication ability of the students. The results of this development reseach the mathematics lesson equipment based on guided discovery approach were valid, practical, and effective.

Keywords – *Guided discovery, lesson equipment, communication ability, plomp model*

PRELIMINARY

One of the subjects that is always taught in every level of education is mathematics. Mathematics is taught from early childhood education to university level. Mathematics is also a science that underlies the development of science and technology, so mathematics is seen as a structured science and integrated patterns of study and relationships, and the science of thinking to understand the world around. This is in accordance with NCTM (National Council of Teachers of Mathenatics) which states that there are 5 (five) basic skills that must be mastered by students and one of them is the ability of mathematical communication [1]. De Lang in Shadiq reveals Mathematical communication is an ability that must be mastered by students [2]. Asikin expresses mathematical communication can be interpreted as a dialogue that occurs in a classroom environment that connects students' thinking with teachers or students with students, so that the transfer of messages about mathematical material learned between teachers and students or among students in the classroom can be realized [3]. But in fact the mathematical communication skills of these learners is still not optimal. This is evident from several studies that have been done before. Among research conducted by Kurniasari mention that only about 14,28% or only four student in MTs in Surabaya who have ability of communication of mathematics classified in very good category [4].

In Mahrani's study of preliminary findings in one junior high school in Aceh found that students' mathematical communication skills were still low, with only 4 students out of 45 students or 8.89% who were able to make mathematical models with complete completion of the steps and correct answers by category Well, 15 students from 45 students or 33.33% were able to make mathematical models with the completion of incomplete steps and correct answers with sufficient categories, and 26 students from 45 students or 57.78% of the students could not make the same mathematical model [5].

Yusra & Saragih in his research also found "Reality found in the field for students' mathematical communication ability of the attention is still small, so the mastery of the competence for the students is still low.From the student's answer, it can be seen that the students only answer questions directly, not focused and difficult When they are asked to explain the students can not express how to get answers, the students just look at the numbers and add them directly From the student's answer it can be concluded that the student has poor mathematical communication skills in communicating answers [6].

Based on observations at SMPN 12 Padang held on 16-18 November 2016, not optimal mathematical communication ability of learners cause low result learners learners. This indicates that the average score of indicators of mathematical communication ability is still low. This shows that the mathematical communication ability of learners who are represented by the four indicators are experiencing problems. Because the average score that must be obtained learners for each indicator has not been maximized. The average number of students' mathematical communication skills only reached 5.48 out of the 12 maximum scores that the learner should achieve.

Based on the results of interviews with some of the students of class VIII SMPN 12 Padang, SMPN 39 Padang and SMPN 25 Padang obtained information, they assume that the math lesson is difficult. Learners should memorize the many formulas and are often confused when given a different matter than what the teacher explained. And based on the questionnaire of student responses that students who are still reluctant to ask if they feel difficulty in learning and students also still think less understand the material explanation given by the teacher.

Based on the results of observations on how to teach teachers obtained some information, first learning activities undertaken by teachers have been referring to the effort membelajarkan learners but the role of teachers is still so dominant that learners have not got enough space to construct his own knowledge. Second, the learning done by the teacher has not familiarized the learners to communicate the knowledge possessed by the students. In addition, learning activities also have not facilitate learners in training communication skills such as in the teacher's efforts to make learning tools are familiarized to the problems that are created to train students' communication understanding.

Another problem that is seen is the learning devices used by teachers not in accordance with the needs and characteristics of students. Teachers already have their own LKPD to be used by students, but because many hours of lessons teachers use to teach materials every day, then LKPD made not yet maximal. The material presented is very succinct so that learners do not see the process to find the concept

In addition to support the development of LKPD required other learning tools such as Learning Implementation Plan (RPP). Feel the results of teacher interviews and observations that researchers do RPP that already contain the correct components, but not complete steps approach that is in the curriculum 13. In RPP teachers in Data Processing activities have not elaborated in detail the activities of students to find a concept , The RPP teachers only instructed students to do LKPD. The material given in class VIII even semester there are 4 pieces of material. According to interviews with teachers of mathematics that exist in SMPN 12 Padang, the most difficult material to be understood by circle students, opportunities and statistics.

One of the mathematical skills to be achieved by learners is the ability of mathematical communication. In communicating math includes the skills or ability to read, write, review and respond to information. Nila Kesumawati in his research mentions mathematical communication is one of the capabilities students must possess because communication is a very important part in mathematics and mathematics education [7]. In the application of learning mathematics, communication occurs through a learning process in which learners are actively involved to share ideas with other students in doing mathematical problems and think and express other opinions related to mathematical concepts / materials. Agus Prianto conduct research with title of Study Material Algebra and Mathematical Communication Student obtained by conclusion that students can deepen formally about elements of algebra emphasis of mathematical ability through discussion with aim of student able to write idea, explain and give mathematical argument to other student and will listen Ideas or opinions of other students [8]. Further research conducted by Viseu and Oliveira concluded that students who do math communication that can encourage the creation of a fun learning. Both orally and in writing, students put forward a mathematical idea by speaking, writing, and describing it and explaining the mathematical concept well. Its meaning is to state the idea of math by speaking students can reinforce a deep understanding of mathematical concepts [9].

Further research conducted by Tinungki GM with the title of The Mathematics Communication Ability in the Subject of Probability Theory obtained conclusion of mathematical communication ability has a significant correlation with learning, thus, the students' understanding with Mathematical communication can be done well [10]. Masrukan also conducted a research entitled Analysis of Mathematical Communication Ability Through 4K Model Based on 7th Graders' Personality Types, it was concluded that teachers should familiarize and guide students to make conclusions in writing using their own words [11].

Thus, the communication of mathematics in the learning process is when the teacher involves learners actively in finding and expressing ideas that exist in the learners themselves against the concept given. Sumarmo provides indicators of mathematical communication skills such as:

1. Connecting real objects, images and diagrams into mathematical ideas.
2. Explain the situation ideas and mathematical relations both orally and in writing with real objects, images, graphs and algebra.
3. Declare everyday events in language or mathematical symbols.
4. Listening, discussing and writing about mathematics.
5. Read written mathematical presentations and compile relevant statements.
6. Creating conjectures, formulating arguments, formulating definitions and generations.
7. Explain and make mathematical questions that have been studied [12].

But the authors conclude and select some indicators of mathematical communication skills that will be used, trained and assessed in this study, namely:

1. Connecting real objects, images, and diagrams into mathematical ideas
2. Describe ideas, situations, and mathematical relationships, orally and in writing with real objects, images, graphs and algebra
3. Declare everyday events in language or mathematical symbols
4. Create conjectures, construct arguments, formulate definitions and generalizations

One alternative teaching materials that can be developed for learners is the Student Work Sheet (LKPD). The learner's worksheet is a teaching material as a complement or supporting tool for the implementation of learning that can contain the material or steps to complete the task. This is in accordance with Prayitno's opinion that LKPD is a means to convey the concept to learners either individually or in small groups that contain instructions for conducting various activities.

LKPD mathematics used by schools has been able to facilitate learners in the learning process, but can still be improved to train students' mathematical communication skills. In an effort to improve the function of LKPD mathematics it is necessary to develop a LKPD mathematics that not only presents the basic concepts only in learning mathematics but also able to improve students' mathematical communication skills.

Learning-based model of discovery learning is one of the lessons that bepijak on constructivist philosophy. Guided discovery learning model is an appropriate choice for improving students' mathematical communication ability because according to Suherman the advantage of learning with guided discovery among other active learners in thinking and reasoning to find the final result [13]. In addition learners can communicate their thoughts about the ideas clearly and precisely. Mathematics is considered a "universal language" with unique symbols so that everyone in the world can use to communicate mathematical information even though their native language is different. Something gained in this way will be more meaningful and longer remembered. This opinion is reinforced by the results of research conducted by Yulianti et al with that mentions that teachers should use guided discovery models in learning mathematics for students to be active and creative. In learning that uses guided discovery models, it provides opportunities for learners to be actively involved, improves learning objectives, fills each other in solving problems, and helps learners come up with ideas, concepts and skills they have learned to discover new knowledge. The application of guided discovery learning with contextual approaches can improve student learning outcomes [14].

Several studies using guided discovery methods are research conducted by Sherly Adrila Fitri to conclude that mathematical learning based on guided discovery method can improve the problem solving ability of students mathematics class VII SMP [15]. Apriadi. S.F in its research the conclusion of mathematical learning by using guided discovery method has been effective to improve students' mathematical representation [16]. In'am and Hajar in his research entitled Learning Geometry through Discovery Learning Using a Scientific Approach concluded that teachers in these activities became more innovative and teachers' abilities increased. Meanwhile, student learning outcomes use discovery learning and during the course of this learning can be very good [17], in his research Maarif. S entitled Improving Junior High School Students' Mathematical Analogical Ability Using Discovery Learning Method obtained the conclusions of improving the mathematical abilities of the analogy of students who received better discovery learning methods than students who studied with expository methods [18].

Furthermore, Siti Nurhayati also developed a mathematics learning tool with the title of Research Development of Mathematics Learning Tool Topics The lines on Triangle through Process Skill Approach Based on Discovery Learning Method in Class VIII SMP have fulfilled valid, practical, and effective criteria [19]. Researchers feel the need to conduct further research because the research focuses only on the subject of the lines on the triangle so that the development of learning tools based on discovery-based mathematics discovery of other subjects still require research. Yoppy Wahyu Purnomo in his research concluded that the learning outcomes using guided discovery models were excellent and students 'creativity was also improved [20], Research conducted by Rosydiah also stated that learning by using guided discovery methods can improve students' learning activities and learning outcomes [21] . Arynda also conducted a research and concluded that the application of guided discovery learning with contextual approach can improve student learning outcomes. In addition there is also an increase in the average of the final grade of students, which increases from. 74.49 to 81.24 [22].

Further research conducted by B. Tompo under the title The Development of Discovery-Inquiry Learning Model to Reduce the Science of Misconceptions of Junior High School Students also explains that the knowledge gained by guided discovery model shows several advantages. One of them is long remembered by the students because in the discovery model guided by students who experienced it themselves. Guided discovery also guides students to deeply investigate concepts but also to familiarize students in solving problems [23]. In a study conducted by Haohao Wang and Lisa Posey under the title An Inquiry-Based Linear Algebra Class stated that the guided discovery-based learning obtained by students' math scores increases. This is reflected in their ability to build mathematical proof logically. In particular, students grow better in solving more complex problems with their own background of knowledge [24]. Yuliani and Saragih in his research entitled The Conclusion and Conclusion of Islamic Junior High School of Medan obtained the conclusion of the process of solving the student's answers to problem solving, concept comprehension, critical thinking, and Students' mathematical abilities with guided discovery models are more varied and better [25].

Applying guided discovery models in the classroom, there are several procedures that should be implemented in general teaching and learning activities. Syah in Hosnan explain the stage of guided discovery model as follows: 1. Stimulation (giving stimulus) 2. Problem Statement 3. Data Collection 4. Data Processing 5. Verification 6. Generalization (Interesting Conclusion) [26].

The formulation of the problem in this research is "How are the characteristics of learning-based mathematics learning model of guided discovery learning that is valid, practical, and effective to improve the mathematical communication ability of VIII students of SMP 2nd Semester" ?, so that the objectives to be achieved in this research are to produce Learning device based on guided invention learning model that is valid, practical and effective to improve mathematical communication skill of VIII grade 2 junior high school students.

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RESULTS AND DISCUSSION

A. Preliminary Research Results

In the preliminary stage of research is a preparatory phase consisting of needs analysis, curriculum analysis, and concept analysis, and learner analysis. At this stage the collection of information about the problems contained in the learning mathematics. Needs analysis is done by observing the implementation of learning activities, interviewing mathematics teacher and students of class VIII SMPN 12 Padang, SMPN 39 Padang and SMPN 25 Padang, observation of learning implementation, giving questionnaires to learners and early ability test of mathematical communication of learners.

Based on interviews with teachers, the conclusion is that in the process of learning mathematics, teachers are more likely to use conventional learning because it is considered more effective in the use of time and learners more quickly understand the material taught because it is directly on the important points only. For methods used by teachers in classroom learning have also not varied, teachers already exist using guided discovery methods but not in accordance with the steps found in guided discovery. LKPD used by teachers is obtained from certain institutions, LKPD is not so help learners to practice doing mathematics problems both at school and at home, but LKPD is not able to optimize the ability of learners to train students' mathematical communication skills, because The material contained in LKPD is only a summary of material and formulas in the form so that students forget more quickly when solving the problem -soal, activities in the existing LKPD not yet optimal train students to find the concept of mathematics. The teacher agrees with the development of LKPD that can help learners to discover and understand concepts and train students' mathematical communication skills through teacher-led discovery activities. For the LKPD specification to be developed, the teacher hands it on the learner's wishes to be its users. To get information about the product specifications desired by the students, the researcher gave questionnaires to 90 students in class VIII in some junior high schools in Padang, SMP 12 Padang, SMPN 25 Padang and SMPN 29 Padang, each school is limited to 1 class only Which were distributed questionnaires. From the results of questionnaires that learners in the less active learning students and are reluctant to ask if there is difficulty in learning and students are still there are reluctant to record what is conveyed by the teacher. When teachers teach students also still think less understanding of material explanations provided by the teacher and there are still students who do not hear the explanation conveyed by the teacher. Students also rarely repeat lessons at home and if there is a student task is not optimal in understanding the material. In school teachers rarely use existing LKS in learning. In the teaching materials that will be used the students are more interested in the blue color more doniman with writing Cambria and Comic Sans MS. According to student teachers also rarely reminded the material that was learned at the beginning of learning, how to teach teachers in feel by the students is also less precise. At the end of the learning the teacher also has not provided enough space for the learners to draw the conclusions more independently. At the end of the lesson also the teacher very rarely reminded the material that will be learned at the next meeting. Based on the observation sheet, it can be concluded that the existing learning tools already contain KI and KD but the existing tools have not covered all the components of the curriculum, the tools have not used the curriculum-recommended model, the existing tools have not helped the students find the concept of learning, LKPD according to the students is not very interesting , LKPD used does not support the implementation of the learning process, LKPD used also there is a language that is less clear for students, so that students become inactive in the learning process. In addition, from the test results seen that still a small percentage of learners who obtained the ideal score. This shows that the mathematical communication ability of learners, each represented by four indicators is still not optimal.

Curriculum analysis is conducted on the study of the curriculum 2013 for the subjects of mathematics class VIII SMP semester 2. In general there is no change in the Basic Competency that has been determined Analysis of the curriculum in question is the development of indicators using guided discovery based learning to organize the material and determine the learning objectives To be achieved at every meeting. All indicators in the designed have been adapted to the KD and indicators of mathematical communication skills but can not be separated from the contextual content.

Conceptual analysis aims to determine the content and subject matter needed in the development of learning tools, by identifying key concepts taught, detailing and organizing them systematically. The arrangement of material to be presented on the subject. Statistics for the size of the data spread starts from the mean, median and mode materials. For the data centering measure starting from the range, then the quartile and the interquartile range, because to seek interquartile range must first find the quartile value

Student analysis was conducted to examine the characteristics of the students in grade VIII SMP. This analysis is used as a consideration in designing learning tools based on guided discovery which includes cognitive level, age, learning style, and motivation on mathematics subjects, and analysis done on some students of class VIII SMP. The analysis is done on the students of class VIII SMPN 12 in semester 2 of academic year 2016 / 2017. The first characteristic is obtained that learners are formal operation stage. Students are aged in the range of 11-14 years. Based on Piaget's research, it is concluded at this age that a child's cognitive development has been in the formal operation stage. At the stage of formal operation, the child is able to solve problems, and reasoning by using abstract things. The use of concrete objects is no longer necessary. Budiningsih argued that the main characteristic of development at this stage is the child has started to think abstractly and logically. Scientific thinking models with the ability to draw conclusions, interpret, and develop hypotheses have been shared by children at this stage. Characteristics of the second learner, based on interviews and observations made, it is known that learners prefer to learn with peer tutors. This is seen when the learning process takes place, if learners do not understand the subject matter taught by the teacher, then most learners prefer to ask with friends. According to learners, asking with friends who have understood can help them to understand the material learned. Students tend to ask their friends, and do not dare to ask directly to the teacher. The third characteristic is that the learners are less concentrated and not even focus on the learning process delivered by the teacher. Many learners who tell stories with friends sebangkunya discuss outside the subject matter when the teacher explains the subject matter in front of the class. At the moment the teacher admonishes them to pay attention to what the teacher explained, but after a few minutes later they will return to tell their friends. The fourth characteristic is that most learners like to group when doing an activity, for example the teacher gives the exercise of the students prefer to do the exercises together with their friends instead of working individually. This character indicates that learners prefer to do an activity together. Furthermore, based on the results of interviews with learners obtained data about the work of parents, daily activities of learners and hobby learners. In general the work of the parents of the learners is self-employed, and the activities done at home are playing and helping the parents. Based on the character encountered, the researchers feel the need to develop LKPD-based learning model of guided discovery that can accommodate the character possessed learners in a positive direction in the learning process. LKPD-based guided discovery is a learning resource that can accommodate the learner's characteristic of discussing or in guided discovery phases, and not focusing on what the teacher describes during the learning process. Learning by using LKPD based guided invention invites learners to be active from the beginning of the learning process. In addition LKPD based guided discovery will also guide learners to actively construct their knowledge independently, and in guidance to find a concept.

B. Learning Tool Design Results

1. Designing RPP

The Learning Implementation Plan (RPP) serves as a guide for teachers in delivering learning materials. RPP is systematically designed which contains the components of RPP writing as stated in Permendikbud No.22 of 2016 on Process Standard [28].

The learning activities presented in the RPP refer to guided discovery-based learning integrated with the use of guided discovery-based LKPD. Presentation of the RPP's identity, core competencies, basic competencies, competency achievement indicators, learning objectives, teaching materials, approaches, models, learning methods, time allocation, learning resources and assessment are similar to RPP in general.

Introduction is an early activity in a learning meeting aimed at focusing the attention of learners to actively participate in the learning process. Learning activities are accompanied by time allocation to facilitate teachers to implement the learning process. In this preliminary activity is an orientation stage that is the initial activity to raise the motivation of learners in the learning process by creating a fun activity to do question and answer and convey the benefits of learning a subject matter.

The core activity is a learning process to achieve the learning objectives. In the core activity, the teacher first instructs the learner to sit in the group, then the learner is confronted with some problems related to the material he / she is studying. Then from the problem learners discuss with their friends, then teachers stimulate learners to construct their own concept of the material by providing questions based on the images given. With this it can develop the learner's thinking to do more meaningful learning activities by way of self-study, finding your own, and constructing your own new knowledge and skills that must be possessed. This step is on problem statement, data collection, data processing, verification and generalization.

Furthermore, the teacher asks one group to present the results of the group discussion in front of the class and provide the opportunity for the students to ask questions or respond to the explanation of the presentation group of this activity on Verification, and generalization. After the group discussion the learners are asked to do the exercises given to see the learners' understanding of the material they have learned. Learning ends with concluding activities that can be done in the form of making a summary or conclusion about the material that has been learned, and the teacher inform the material to be learned at the next meeting and the teacher to assess the work of the learners.

2. Designing LKPD

Presentation of materials on LKPD begins with Teachers able to start PBM activities by asking questions, book reading suggestions, and other learning activities that lead to problem-solving preparations. Stimulation at this stage serves to provide a learning interaction condition that can develop and assist learners in exploring materials

Furthermore, the competency test contained in LKPD aims to train students' mathematical communication skills. LKPD uses simple and communicative language and in accordance with the communication level of learners, so that the presentation of the material on LKPD can be well understood. The questions in LKPD are arranged with clear sentences so that they can direct LKPD students designed with varying color and bright to get the expected answers.

a. Self Evaluation Results

The first activity undertaken after designing the learning device is self-examined by the researcher. Before consulting and discussing to the experts, self-evaluation (self evaluation) first to the learning device that has been designed. There are four aspects that are evaluated in the RPP, namely the RPP contains the steps of guided discovery, the accuracy of typing, the use of appropriate words and terms and proper use of punctuation. In LKPD there are seven aspects evaluated: LKPD already contains guided discovery steps, correct typing, proper use of words and terms, proper use of punctuation, proper text size, precise placement of images and unpredictable availability of place for problem solving .

In LKPD errors many of the use of proper punctuation and accuracy of typing as weight of weight should be weight, class should be separated into the writing class, Sevi Name should be Selvi, the use of punctuation at the end of the sentence does not use the point, the problem should be the problem, The Marching Band should be in the Marching Band inclined, as it is an English term. In the RPP errors such as at the end of many sentences without the use of punctuation marks, the first RPP identity in School / Madrasah should be School only. Furthermore imterkuartil jangauan should be written in interkuartil range, Problems on the problem of writing in uniform, if first use writing the letter Cambria so on also use the letter Cambria.

b. Experimental Tool Validation Results Expert

Invention-based math-based learning device is validated by 5 experts, namely 3 lecturers of mathematics, 1 lecturer of educational technology and 1 lecturer of Indonesian language. In the RPP aspects observed are the components and format of RPP, the identity of the RPP, the formulation of indicators of achievement of competence, the formulation of learning objectives, approaches and methods of learning, teaching materials, selection of learning resources, details of learning steps, assessment, language and writing and RPP benefits.

During the validation process there are several revisions suggested by the validator. Based on the suggestion of the validator there are some things that need to be improved in terms of writing the abbreviation of the title of RPP, numbering steps of learning activities, the end of the learning section please write the next material that will be learned by the learner and the penalaian section there is no clear scoring way. After the repair is done, the validators provide an assessment of the RPP that has been designed.

Overall the RPP was developed on valid criteria with an average of 0.764 validity index. Thus, it can be concluded that this guided discovery-based RPP is valid. Validation of LKPD to some aspect that is presentation aspect, content feasibility, linguistic aspect and aspect of kegrafikaan or appearance. During the validation process there are several revisions suggested by the validators. After the repairs are made, the validators provide an assessment of LKPD. Data analysis of content aspect validation results / contents of LKPD obtained validity index of 0.83 with valid category. this means LKPD can help learners to improve their mathematical communication skills.

And than in the aspect of kegrafikaan or display this in the validation by one lecturer Educational Technology, data analysis results validation aspects of graphics or display with the validity of the index obtained 0.74 with valid categories. The next aspect is the language aspect. This language aspect is validated by one Indonesian lecturer with a validity index of 0.80 with a valid category.

The average LKPD overall validity index of all aspects is 0.79 with valid category. Thus, it can be concluded that LKPD-based guided discovery has been valid in terms of content, look and language. After the validation process is completed, it is performed according to the validator's suggestion.

c. Results One to One Evaluation

Individual evaluation is done by asking three students to try to fill LKPD. All three are students of class VIII.6 SMPN 12 Padang, the three learners have different abilities that is one high-ability person, one medium-skilled and one low-ability person. The aspects observed in LKPD are the part of the usage manual, the problem section, the use of the term, and the questions that are difficult for the learners to understand in LKPD. They were asked to try to fill out the LKPD after which they were asked to comment on the LKPD given.

At the first meeting with the average material (mean) there is a revision in LKPD, there is addition of information on understanding the amount of data and a lot of data and average. Prior to the revision of the written statement to find the average value, first Ananda must know the meaning of the amount of data and a lot of data, after the revision added information so it is written to find the average value, first Ananda must know the meaning of the amount of data and many data. Find as much information as possible about the number of data and a lot of data !,, as well as the meaning of the average, there is a revision to LKPD by adding information. Before the written revision can we find the average value on the problem I earlier? What do you know about the average value of a dataset? Then after the revision to be written can we find the average value on the problem I was? Seek as much information as possible about the meanings of the averages of the data set.

At the first meeting also observed improving the communication ability of learners by observing the exercises of students who are high-ability, moderate and low. For highly skilled students can already declare daily events in mathematical language. The student has precisely written exactly the average symbol ($\bar{x}$), the amount of data (Σx) and lots of data (n).

At the second meeting with median matter (middle value). The revised aspect omits the word datum on the question in LKPD, because students do not know the datum and are replaced with the word value.

At the second meeting was also observed improving the communication skills of learners by observing the exercise of highly capable students have been able to connect the diagram into mathematical ideas. For students with moderate and low ability. For students who are capable of being able to connect the diagram into mathematical ideas but the explanation is not logically arranged.

Third meeting with material mode. There is still a revision of LKPD where students must find that the value of the mode can be more than one so in add the information on LKPD. Before the written revision After Ananda knows the definition of the mode value in problem I, can Ananda determine the mode value of problem II. What is the value of mode in problem II? Try to explain! After the written revision After Ananda knows the definition of the mode value in problem I, can Ananda determine the mode value of problem II. What is the value of mode in problem II? Try to explain! According to Ananda whether the value of the mode can be more than one? Try to explain!

At the third meeting also observed improving the communication skills of learners by observing the exercise of highly capable students have been able to connect the diagram into mathematical ideas. For students with moderate and low ability. For skilled sisswa are able to connect diagrams into mathematical ideas but the explanation is not logically arranged.

Fourth meeting with reach material. There are still revisions to LKPD-based guided discovery about commands or questions to get students to conclusions.

At the fourth meeting also observed improving the communication skills of learners by observing highly skilled student exercises have been able to connect the diagram into mathematical ideas. For students with moderate-to-moderate abilities are also able to link diagrams into mathematical ideas

The fifth meeting with the quartile material and the interquartile range. From the results of observation at the time students do LKPD 5 students provide comments, among others, there is a mistake in the word "problem 1". So that revision is made. Furthermore there is an error in writing the word Ananda, previously written you.

At the fifth meeting also observed improving the communication skills of learners by observing highly skilled student exercises can already connect diagrams into mathematical ideas. For skilled sisswa are able to connect diagrams into mathematical ideas but the explanations are not logically arranged. For low-ability students not yet able to connect digrams into mathematical ideas.

At the sixth meeting also observed improving the communication skills of learners by observing the exercise of highly capable students have been able to connect the diagram into mathematical ideas. For middle and low-ability students, it can link diagrams to mathematical ideas but the explanations are not logically arranged.

d. Small Group Evaluation Results

The activity is to test the practicality of instructional tools by small group evaluation (small group). Small group evaluation is done by practicing instructional tools that have been designed on a group of learners consisting of 8 people. This small group evaluation was conducted on students of class VIII.6 SMPN 12 Padang with high ability, moderate, and low. This evaluation is done for six meetings there are some revisions to the device such as the commands that exist on LKPD based guided discovery.

The first meeting with the average material (mean) In the preliminary activities of the students are given stimulus by the teacher about the problems associated with a number of students who are weighing the body with the number of students 20 people. The learner looks enthusiastic in filling out an answer column that contains the question "find the average score of SMPN Pemuda", as well as for one-to-one problems, the learner looks enthusiastic about writing the information and writes down what problem the story asks.

When they understand the second problem, learners seem to be hesitant, they ask "what is the answer immediately?", Then the teacher gives guidance to follow every step - the step of his activities first, because in every step of the activity will directly answer the problem. When learners follow every step of activities in LKPD, learners are confused with the first question and the second question, for the one student question asking "do we just write the information alone?", Then the teacher gives guidance that for the problem of our one only Write down important information only, therein lies the steps of guided discovery, after being given the problem and then write down the information or important data contained in the problem. Then there are students who add that if you have written information, there should be a question or a problem. It becomes a note for researchers to add questions in LKPD. Learners also hesitantly answered the third question. Written or calculated also to find the average value. Because there are learners who only write the data only, do not not add up so that the author revises the calculate the amount of data and a lot of data from the above problems. So is the average.

In the matter of the exercises given at the end of the learning that contains the problem of mathematical communication has seen an increase. This can be seen from the acquisition of scores for questions 1 and 2 with indicators indicating symbols into everyday life. Of the 8 students, for the problem no.1 seven people who get a score of 4 and one person get a score of 2. For the matter no.2 seven people get a score of 4, This means 100% of students who got the ideal score.

Based on the results of the analysis of 8 students who do the exercise questions on LKPD, 6 students or 75% complete means the value of learners above the determined KKM score and 2 students or 15% have not completed meaning that the value of students still below KKM.

The second meeting took place on March 25, 2017 at the first lesson, discussing material on the median. At the second meeting, students can understand LKPD well and finish LKPD in accordance with the time specified. At the time the teacher provides a median stimulation, in terms of determining the number of houses in the middle. Learners seem enthusiastic to comment and write their answers in the fields that have been provided. In step problem statement (problem giving) seen learners in their group can discuss each other, brainstorm, give each other respond in menyelesaiakan problem and step - step in activity LKPD.

In this second LKPD there are doubts for high-performing learners when following the steps of activities in solving the second problem, so that revision is made. The addition of such information is after the learners write down information or things that are known and usually learners also write down what was asked. So the authors add a revelation of what is asked or what problems can Ananda meet in the illustration above story !. For a matter of data revision made in the matter of written stories made using diagrams of stems.

In the matter of the exercises given at the end of the learning that contains the problem of mathematical communication has seen an increase. This is evident from the acquisition of scores for questions 1 and 2 with indicators linking diagrams into mathematical ideas. Of the 8 students, for a matter of no.1 six people who got a score of 4, two people got a score of 2. For question no.2 five people got a score of 4 and 2 people got a score of 2, This means 87% of students who got the ideal score.

Based on the results of the analysis of 8 students who do the exercise questions on LKPD, 6 students or 75% complete means the value of learners above the determined KKM score and 2 students or 15% have not completed meaning that the value of students still below KKM.

The third meeting took place on the date after school home March 31, 2017 using LKPD 3 discussing the material about "mode". In the third LKPD there is doubt for low-ability learners when following the steps of activities in solving the second problem, so that the revision is made. The addition of such information is after learners write down information or things that are known and usually learners also write down what was asked. So the authors add a revelation of what problems Ananda encountered in the illustration above? Previously written After reading the above problem Write down the information Ananda knows from the problem I! Then revised on the second issue. Learners still do not understand write down the information or in the know, learners only meuliskan short answer so that written revision after reading the problem above, write what information in the know from problem II berdasrkan tebel didtribusi age Marching Band Member! Previously learners just write the information alone.

In the matter of the exercises given at the end of the learning that contains the problem of mathematical communication has seen an increase. This is evident from the acquisition of scores for questions 1 and 2 with indicators linking diagrams into mathematical ideas. Of the 8 students, for a matter of no.1 six people who got a score of 4, two people got a score of 3. For question no.2 five people got a score of 4 and 3 people got a score of 2, This means 100% of students who got the ideal score.

Based on the results of the analysis of 8 students who do the exercises on LKPD, 8 students or 100% complete means the value of learners above the KKM value.

The fourth meeting took place on April 1, 2017 after going home from school using LKPD 4 discussing "reach" materials. There are still some revisions, in the statement can Ananda determine the range, learners are capable of asking sedanng what is meant is to determine the understanding of the range, so the authors make revisions sehungga written statement After knowing what the definition of coverage calculate the range of the above I? With revision to write the largest value and the smallest value, it is revised by replacing its command to determine the smallest value and the biggest value of the problem I. Further revision of exercise problems by replacing the previous data in the form of a matter of certita to form a bar chart.

In the matter of the exercises given at the end of the learning that contains the problem of mathematical communication has seen an increase. This is evident from the acquisition of scores for questions 1 and 2 with indicators linking diagrams into mathematical ideas. Of the 8 students, for a matter of no.1 six people who got a score of 4, two people got a score of 3. For question no.2 five people got a score of 4 and 3 people got a score of 2, This means 100% of students who got the ideal score.

Based on the results of the analysis of 8 students who do the exercises on LKPD, 8 students or 100% complete means the value of learners above the KKM value.

The fifth meeting in terms of understanding the mathematical concepts of some students seems to give their opinion on the term quartile and interquartile range. The terms they understand not from the teacher but from examples of problems given in LKPD, through the problems they provide definitions and examples of the terms according to their respective understanding - each. In LKPD five and six there are doubts for high-performing learners when following the steps in solving the second problem, so that revision is made. The addition of such information is after learners write down information or things that are known and usually learners also write down what was asked. So the authors add a revelation of what is asked or what problems can Ananda meet in the illustration above story !. Furthermore students also asked whether the data should still be in the order between the smallest value and the middle quartile value? So that revision is done to sort the lowest value data up to median value! So that the command is added Once Ananda finds the median or middle quartile (Q2), sort the data from the lowest to Q2!

In the matter of the exercises given at the end of the learning that contains the problem of mathematical communication has seen an increase. This is evident from the acquisition of scores for questions 1 and 2 with indicators linking diagrams into mathematical ideas. Of the 8 students, for the number no.1 five people who scored 4, two people got a score of 2 and one got a score of 1. For question no.2 four people got a score of 4, 2 people got, This means 56.25% Students who got the ideal score.

Based on the results of the analysis of 8 students who do the exercise questions on LKPD, 6 students or 75% complete means the value of learners above the determined

KKM score and 2 students or 15% have not completed meaning that the value of students still below KKM.

C. Results of Assessment Phase

At this stage field tests are conducted to see the effectiveness and effectiveness of guided discovery-based learning devices.

1. Practicality of Guided Instruction Based Learning Device

The results of revisions to individual and small group evaluations were followed by field tests in grade VIII.4 SMPN 12 Padang. Testing of discovery-based learning tools guided by large classes was conducted 6 meetings. During a large class trial, researchers were assisted by one teacher and one observer. Teachers teach with tools that designers have designed. Observer in charge of observing the implementation of learning with guided discovery based learning tools using observation sheet implementation. Observations made on the learning process, the class situation, the interaction that occurs, in general the activities of teachers and learners.

Practical data of learning-based learning-based learning tools were obtained from teacher and student questionnaires and observation of learning implementation. The results of a large class field trial of the practice of learning-based learning tools based on the detailed discovery are obtained as follows.

a. Result of Questionnaire Praktikalitas by Learners.

The average overall value of LKPD practicality obtained from the questionnaire of students is 82.77 with very practical category based on the criteria of practicality. From the results of questionnaire analysis filled by LKPD students interesting, can be well understood, can motivate learners to learn math, easily understand the concept and solve the problem well. Thus it can be concluded that LKPD based guided discovery is practical for use in learning mathematics in class VIII SMP.

b. Result of Practical Questionnaire by Master

Questionnaire of learning device learning toolality is given to Mathematics teacher of class VIII SMPN 12 Padang after learning is done. Generally, the average result of questionnaire of teacher response to learning device based on guided discovery is 86,78 with very practical category. From the results of questionnaire analysis filled by teachers, learning tools easy to use, interesting, can be understood well, can help teachers present material and time is used enough. Thus, it can be concluded that the learning tools used are practical.

C. Observation Results of the Implementation of Guided Instruction-Based RPP

The practicality of the implementation of RPP is 81.70 with very practical criteria. Thus it can be concluded that this guided discovery RPP has been practically used and implemented by teachers in learning mathematics class VIII SMPN 12 Padang.

Based on the one-to-one evaluation, small group, and filed test activities, each step has revised and revised the learning tools. From the observation of the implementation of learning activities and questionnaires given to learners, teachers, as well as observers of learning tools used can be concluded that the guided learning of mathematics-based learning guided practical use in learning mathematics.

2. The effectiveness of Guided Instruction Based Learning Devices

The effectiveness of instructional tools viewed from the results of mathematical communication ability of learners. Invention-based learning-based learning tools can be said to be effective if able to test the ability of students' mathematical communication ability 75% above KKM. Problem test given as many as 4 pieces of questions. Problem test validated to 3 lecturers of mathematics education.

Based on the results of the analysis of 34 students who took the test, 29 students or 85% complete means the value of learners above the determined KKM value and 5 students or 15% have not completed meaning the value of students are still below the KKM. Furthermore from the average class of learning using guided discovery-based learning tools that is 90.11 means that have been clasical classical show.

On the indicators Connecting images to mathematical ideas 86.71% of learners managed to get an ideal score, meaning that most learners are able to connect images into mathematical ideas that have been studied correctly and using the right notation or term. Some learners who have not achieved the ideal score because it does not connect the image into the mathematical idea that is in their answers there who do not understand how to read bar charts or lines on the issue. Furthermore the ideal score on indicator Declare everyday events in language or mathematical symbols is also achieved by 82.35% of learners. Some learners who have not achieved an ideal score are caused by two things: an incomplete or partial answer is still wrong.

In the indicators make conjecture, formulate the argument, formulate the definition and generalization only 52.94% of students who achieve score 4, but 2.94% of students have reached the score 3 and 44.11% got a score of 2. Learners who mostly got score 2 because an incomplete answer, such as the identification of information that is known and asked to be incomplete or absent, does not answer the estimate of the number being asked, and no interpretation of the calculation result has been done. This means that most learners have been able to make conjectures, formulate arguments, formulate definitions and generalizations on statistical materials.

Development of LKPD based guided discovery is said to be effective if more than 75% of learners get the value of ≥ KKM. Based on the result of final test analysis, it can be concluded that the use of guided discovery based learning device has been effective since it has been more than 75% who got the value above KKM.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of data analysis that has been done can be concluded that guided invention-based learning device designed has been valid, practical, and effective use to improve mathematical communication ability of class VIII SMP students. Based on the above conclusions, the guided discovery-based learning tools can be used as a guide for teachers in implementing learning to improve the mathematical communication skills of learners.

Increased mathematical ability can be seen in One-to One Evaluation by doing observation to answer exercise problem on LKPD which is done by students who have high ability, moderate, and low by using indicator ability of mathematical komuniksi. Viewed whether students can properly declare daily events in symbols in mathematics, students can link diagrams into mathematical ideas correctly and logically and students can construct conjectures appropriately. Small Group Evaluation by looking at the ideal score score (score 4 and score 3) for each item in the LKPD-based guided discovery exercise using mathematical communication ability indicators. Furthermore, seen from the KKM completeness, if the test results of mathematical communication ability of the learner 75% above KKM. Field Test by looking at the ideal score score (score 4 and score 3) for each item in the LKPD-based guided discovery exercise using mathematical communication ability indicators. Furthermore, seen from the completeness of KKM if the test results of mathematical communication ability of learners 75% above KKM.

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IMPROVING PROBLEM SOLVING SKILL OF STUDENTSBY USING M-APOS THEORY

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Abstract

The aims of this study is to discuss an alternative theory that is suitable to use to improve the problem solving skill of students at the level of junior high that still low.One of the causes that make students's problem solving skill still low is the theory of learning that teachers use was couldn't improving desire of students in solving math problems. The alternative theory to improve the problem solving skills of student in this study is the M-APOS theory.Theory of M-APOS is a modification of the theory of APOS (Action-Process-Object-Scheme). Modification is on the activity phase, where the activities in the computer labs on the APOS model are replaced by the students's work sheet (LKPD). The method used in this study is a study of literature studies, that is by collecting data about M-APOS to problem-solving skill from various sources such as relevant research, books, etc. After conducting literature studies by citing data from various sources, it is suspected that M-APOS theory can improve students' problem solving skills at Junior High School level.

Keywords:*M-APOS theory, problem solving skill*

INTRODUCTION

Mathematics is a subject that has important roles and functions for students in every level of *education* ranging from elementary school (SD) even up to university for some majors. There are many reasons why mathematics has an important role or function for students. As stated by Cornelius (in Abdurrahman, 2012: 204) that there are five reasons for the need to learn mathematics because mathematics is (1) a clear and logical means of thinking, (2) the means to solve problems of everyday life, (3) Patterns of relationship and generalization of experience, (4) means to develop creativity, and (5) means to raise awareness of cultural development.

Furthermore Cockroft (1982: 1) argues that mathematics needs to be taught to students because (1) Mathematics is regarded by most people as being essential, (2) Mathematics is only one of many subjects which are included in the school curriculum, (3) Mathematics provides a means of communication which is powerful, concise and unambiguous, (4) Mathematics can be used to present information in many ways, (5) Develop powers of logical thinking, accuracy, and spatial awareness, and (6) Give satisfaction to attempt to solve challenging problems).

Because mathematics has many functions in life, including for junior high school students and to achieve all that it is compiled the purpose of learning mathematics in junior high school that content has similarities with the purpose of learning mathematics at high school level and Vocational high school. All the objectives of mathematics learning are contained in Permendiknas No.22, 2006 whose contents are:

(1) Understanding the concepts of Mathematics, explaining interconnectedness and applying concepts or algorithms, flexibly, accurately, efficiently and appropriately, in problem solving;(2) Using reasoning on patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements; (3) Solve problems that include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained; (4) Communicating ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems; (5) Appreciate the usefulness of mathematics in life, which has a curiosity, attention, and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving.

From the purpose of learning mathematics above one of the most important part is student problem solving abilities. As expressed by Hudojo (2005: 130) that problem solving has an important function in teaching and learning activities in mathematics. Through problem solving students can practice and integrate the concepts, theorems and skills learned. Furthermore he also said that teaching students to solve problems allows students to be more analytical in making decisions in life.

Although problem-solving skill is very important in teaching and learning activities of mathematics, but based on the results of literature studies conducted by the author by way of analyzing previous studies of junior high school students, found that the problem solving ability of junior high students is still low.This is derived from the results of research conducted by Hoiriyah (2014), that of 40 students there are 70% of students who have not been able to write what is known and asked, 75% of students have not been able to plan the problem resolution, 80% of students have not been able to do Calculations correctly, and 90% of students have not been able to review procedures and outcomes.

The low skill of mathematical problem solving of students is caused by several factors, one of them is the less innovative teacher in choosing the model, the method, the approach, the strategy and the learning technique which can increase the students' desire in solving the math problem.As expressed by sudiarta in sarbiyono (2016), the main factor causing low skill of mathematics problem solving of student, that is learning which has been done so far not able to develop problem solving skill of student.

Based on the above problems then we should be as an educator able to create learning that can improve students problem solving skills so that the purpose of learning mathematics can be achieved. Because the solving skill can be achieved when students are exposed to conditions that can elicit students' desire to practice their problem-solving skills, the condition is raised during the learning process.This means that a teacher must choose theories, models, methods, approaches, strategies and learning techniques that can improve student problem solving skills.

The use of various theories and learning models in teaching becomes imperative for a teacher when doing the learning process in the classroom. The requirement is contained in Permendiknas no. 16 year 2007 about the standard of academic qualification and teacher competence, competence related to the use of various model or approach in teaching is pedagogic competence.Therefore, in this literature study, the writer gives solution one of learning theory that can support and improve the problem solving ability of mathematics student of SMP that is M-APOS theory.

The M-APOS theory is a modification of the theory of APOS (Action-Process-Object-Scheme). Modifications are made to the activity phase, where the activities in the computer lab on the APOS model are replaced by the assignment of the recitation assignment given before the learning begin. Recitation tasks are presented in the form of student activity sheets that guide and assist students in reviewing concepts or solving mathematical problems.

Based on the problems that have been found above, it is assumed that M-APOS learning theory can improve students' problem solving Skill And therefore the authors conducted a study using literature study method entitled "Improving Problem Solving SkillOf Student by Using M-APOS Theory".

THE RESEARCH METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. These data sources contain: Mathematical problem solving abilities and M-APOS Theory. These sources are obtained from journals, books, research report articles and internet sites.

RESULT AND DISCUSSION

Problem solving is a part of teaching and learning strategy that is very important especially in teaching and learning activities of mathematics. This is as stated by Hudojo (2005: 130) states that problem solving has an important function in teaching and learning activities in mathematics. Through problem solving students can practice and integrate the concepts, theorems and skills learned. Furthermore he also said that teaching students to solve problems allows students to be more analytical in making decisions in life.

In other words, when a student is trained to solve a problem, the student will be able to make a decision because the student becomes skilled about how to gather relevant information, analyze information and realize how much research needs to be re-examined.

In problem solving should be considered the steps in the solution. According to Polya (1973: 5), there are four main stages in the process of mathematical problem solving, that is: First, we have to understand the problem; we have to see clearly what is required. Second, we have to see how the various items are connected, how the unknown is linked to the data, in order to obtain the idea of the solution, to make a plan. Third, we carry out our plan. Fourth, we look back at the completed solution, we review and discuss it.

Meanwhile, according to Krulik and Rudnick (in Carson, 2007: 7) said that there are five steps that can be done in solving the problem, that is: 1) Read and think (*membaca dan berpikir*), 2) Explore and plan (*mengeksplorasi dan merencanakan*), 3) Select a strategy (*memilih suatu strategi*), 4) Solve (*memecahkan masalah*), dan 5) Review and extend (*meninjau kembali dan mendiskusikan*).

Further the steps of problem solving is according to Dewey (in Carson, 2007: 7): 1) Confront problem (*mengenali masalah*), 2) Diagnose or define problem (*mendiagnosa dan mendefinisakan masalah*), 3) Inventory several solutions (*perumusan beberapa solusi*), 4) Conjecture consequences of solutions (*dugaan solusi*), dan 5) Test consequences (*mencobakan*).

Based on the description of the troubleshooting steps mentioned above it can be seen that the activity in the second and third steps of Krulik and Rudnick is similar to the second step of solving Polya problem. While the first and second step activity of

Dewey is the same as the first step of solving Polya problem. A comparison of the troubleshooting steps from the three opinions above is summarized in the following table.

Table 3.1 Comparison of Problem Sloving Steps

Steps		
Krulik dan Rudnick	**Polya**	**Dewey**
1. Read And Think (*Membaca Dan Berpikir*)	1. Understand The Problem (*Memahami Masalah*)	1. Confront Problem (*Pengenalan*)
		2. Diagnose Or Define Problem (*Pendefinisian*)
2. Explore And Plan (*Mengeksplorasi Dan Merencanakan*)	2. Devise A Plan (*Membuat Rencana*)	3. Inventory Several Solutions (*Perumusan*)
3. Select A Strategy (*Memilih Suatu Strategi*)		
4. Find An Answer (*Menemukan Suatu Jawaban*)	3. Carry Out The Plan (*Melaksanakan Rencana*)	4. Conjecture Consequences Of Solutions (*Menduga*)
5. Review And Extend (*Meninjau Kembali Dan Mendiskusikan*)	4. Look Back (*Memeriksa Kembali*)	5. Test Consequences (*Mencobakan*)

Although there are different indicators of problem-solving skill from some experts, the ones that will be discussed in this literature study are indicators of problem-solving skills according to their methods. Here are the troubleshooting steps according to Polya along with the problem solving indicator.

Table 3.2 Problem Solving Indicators of Polya

Steps of Problem Solving By Polya	**Problem Solving Skill Indicators**
Understand The Problem	Identify the adequacy of data to solve a related problem.
Devise A Plan	Create related plan solutions
Carry Out The Plan	Resolving the problem in accordance with the plan that has been made in solving related problems.
Look Back	See if the results to be obtained can be viewed at a glance

According to Eka Lestari Gifts (2015), the M-APOS learning model is a model of learning based on the modified APOS (Action-Process-Object-Scheme) theory. Modifications are made to the activity phase, where the activities in the computer lab on the APOS model are replaced by the assignment of the recitation assignment given before the learning takes place.Recitation tasks are presented in the form of task sheets (LKPD) that guide and assist students in reviewing concepts or solving mathematical problems.

The sense of action, process, object and schema according to (Arnon and Dubinsky, 2009): (1) Action: The first thing students perceive in experiencing a transformation is action or action, ie students react to stimuli coming from outside, Students show the nature of the curiosity or do the task given by the teacher.(2) Process: at this stage students repeat and reflect an action, the action may be incorporated into the mental process. A process is a mental structure that performs the same operation as an action, but fully in the mind of the student. In particular, students can imagine performing transformations or actions without having to do each step explicitly. (3) Objects: If the student understands the process done maximally and can realize it then the student can be said to have put the process into the cognitive object (4) Scheme: students are said to have done the scheme if the students are able to connect some actions, processes and objects about a mathematical material coherently.

Based on the above, the following will be discussed how M-APOS theory can improve students problem solving skills. The first stage in learning using M-APOS is Action, where action is a reaction to the stimulus given where the individual feels as an external. Besides this concept of action is when learners perform calculations and transformation of mathematical objects as a result of external stimuli such as entering numbers for variables in the formula, he can also perform many step algorithms by triggered by the previous step (Marcela, 2009).When students receive external stimuli and take various actions to receive the stimulus as a whole, for example when the teacher gives LKPD to the learners then gladly and pernuh antusuias learners to read and understand the commands of the LKPD then this can improve the indicator of the ability of splitting The first problem, that is understanding the problem. Because at the stage of understanding the malasah learners are expected to be able to identify the adequacy of data to solve a related problem.

The process, which is the mental structure that performs the same operations as the action, but is entirely based on individual thinking, or when learners can reflect actions, two or more processes can be coordinated to form new processes (Marcela, 2009). In this process activity learners have initiated repeated actions to finalize the problem-solving plan that existed in LKPD or tasks assigned by the teacher. This means that in the activity of this process the students are able to understand the problem and plan the problem solving. So at the stage of the process can increase the first and second problem solving inidikator that is understanding the problem and plan the settlement, because at this stage students have done the action repeatedly, when students have done the action then the students have tried to understand the problem and if students already understand the problem Then the student will try to plan the problem. So in the process activities can improve indicators understand the problem and plan for problem solving.

Next is the Object. The stages of an object occur if one becomes aware of the process as a totality, realizing that the transformation can act either it explicitly or in the imagination of a person can be said the individual has packed the process into a cognitive object. Or when the need arises to transform the process and can take action to find out the results of the actions and processes that have been done (Marcela, 2009). At this stage learners have repeatedly perform Action and Process until finally students find the results of action and process activities. This means that when stedents are at the stage of the object then learners have done activities to understand the problem, plan the completion, and do the settlement plan. This happens because at this stage learners have gone through the action and process activities, meaning that students are able to understand the problem and plan the problem solving, then the object learners try to implement the problem solving plan to be able to solve the problem. So at the stage of the object can improve indicators understand the problem, plan the problem solving, and carry out the problem solving.

And the last is Scheme, according to Marcela (2009) scheme is a coherent structure of a learned concept that can be used in problem solving. This stage is a complex stage of M-APOS activity means that in this stage learners have been able to solve the problem because it has done the action, process, and object. And hereinafter in this stage learners can find a general conclusion and solution of the problem that is by trying to solve other problems similar to previous problems so that learners can re-examine the settlement of the problems that have been done in the previous stage. So the scheme can improve all the indicators of the problem solving ability of the learners because at the stage of the student scheme has gone through all stages of M-APOS.
The following is a chart of the relationship between M-APOS and the problem solving skill indicator.

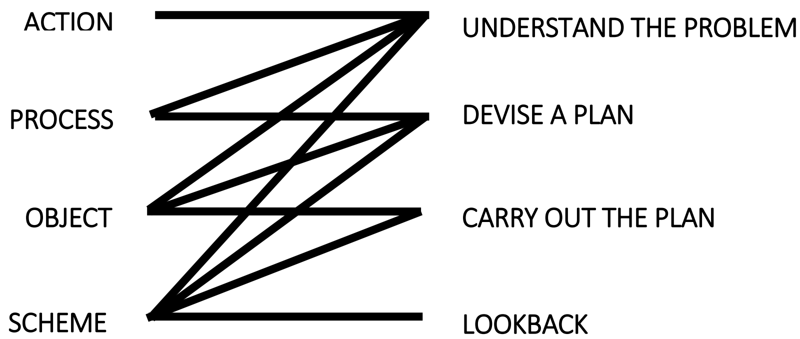

Figure 3.1. Relationship Between M-APOS and Problem solving skill Indicators

This is also supported by the results of research that has been done by Gifts Eka Lestari (2015) at the junior level which concluded that the improvement of students' mathematical problem solving skills whose learning with the M-APOS learning model is better than the students whose learning with conventional learning model using Expository methods. It can be seen from the analysis of index data from the two classes which shows that the improvement of problem solving ability of the experimental class mathematics is better than the control class.

Furthermore, it is also supported by the opinion of Dubinsky (in Aneshkumar Maharaj, 2010) which states that APOS Theory and its application to teaching practice is based on the following assumptions: The mathematical knowledge assumption, in which an individual's mathematical knowledge of the tendency to respond to situations of perceived mathematical problems and their solutions with Contemplating in a social context and building or reconstructing the mental structure to be used in solving existing problems.

This means that learning with M-APOS approach will increase the problem solving ability of learners. Based on the above description and supported by some relevant previous research, it is expected that the problem solving ability of junior high school students can be improved by using M-APOS theory.

CONCLUSION AND SUGGESTION

M-APOS theory is a learning theory that can improve the problem solving skill of students. The relationship between each section on M-APOS with the indicators of problem solving skill are as below:

- Action can improve the ability to understand the problem

- Process can improve the skill to understand the problem and devise a plan
- Object can improve the skill to understand the problem, devise a plan, and carry out the plan
- Scheme can improve the skill to understand the problem, devise a plan, carry out the plan and look back.

Based on literature studies that have been done then the authors suggest:

1. For teachers or educators who want to improve students problem solving skills then the theory of M-APOS is one alternative that can be applied to students.
2. For the next writer who wants to write about M-APOS it is suggested to study how to improve students' mathematical ability by using M-APOS at other level, such as SMA or SMK

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ANALYSIS OF MATHEMATICAL PROBLEM SOLVING SKILLS OF CLASS X HIGH SCHOOL STUDENTS BASED ON MULTIPLE INTELLEGENCE IN LEARNING PBL

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Abstract

This study aims to analyze the skills of solving mathematical problems of class X high school students based on multiple intelligence on PBL learning which is viewed from students' early mathematical skills. Problem solving is a process of finding solutions to problems related to learning materials using existing knowledge. Problem solving is an exercise for students to deal with something that is not routine and then try to solve it. In solving a problem, students must combine and connect previously acquired understandings. Multiple Intelligenceis the different skills and talents of a student to create a product and solve problems in learning.Multiple intelligence is needed to facilitate students to learn a material because the material is delivered in accordance with the prominent intelligence in the students. Problem Based Learning (PBL) is a learning model that departs from a student's understanding of a problem, finds an alternative solution to the problem, then chooses the right solution to be used in solving the problem. This approach will focus the analysis of students 'ability in solving problems of mathematical problem solving based on multiple intelligence on PBL learning which is viewed from students' early mathematical skills. Thus, by looking at early mathematical skills students can analyze the skills of solving mathematical problems based on Multiple Intelligence on PBL learning.

Keywords: *Problemsolving, Multiple Intelligence, Problem Based Learning.*

INTRODUCTION

Mathematics is one branch of science that is very close to everyday life. This statement is consistent with the opinion of Chambers (2008: 8), which states that "mathematics is characterized as a tool for solving problems, the underpinning of scientific and technological study, and provision of ways to model real situations". Mathematics is classified as a tool for solving problems, pillars of science and technology, and provides a way to demonstrate real problems. In the National Council of Teachers of Mathematics (NCTM, 1989: 5) stated several objectives of mathematics learning, namely: 1) Learning to value mathematics, 2) Becoming a mathematical problem solver, 4) Communicate mathematically, 5) Learning to reason mathematically

Therefore, mathematics was introduced from an early age, from elementary, middle, and even to college students. Given the importance of mathematics in life, it takes a variety of efforts in improving the quality of mathematics education in schools. One effort that can be done is to create a meaningful learning process. Meaningful learning will occur when students can relate between subject matter with daily life as well as with other knowledge. Such linkage will require students to learn math well.

In the Regulation of the Minister of National Education of the Republic of Indonesia No. 22 BSNP (2006) stated that: the purpose of mathematics subjects is that students have the following capabilities: (1) understanding the concept of mathematics, explaining the interconnection between concepts and applying concepts or algorithms, flexibly, accurately, efficiently and appropriately in problem solving, (2) using reasoning on patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements, (3) solving problems that include the ability to understand problems, designing mathematical models, solving models and interpreting solutions obtained, (4) communicating ideas with symbols, tables, diagrams, or other media to explain the situation or problem, (5) having an appreciative attitude to the use of mathematics in life ie possessing curiosity, attention and interest in learning mathematics, and tenacious and confident in solution to problem.Based on these statements it can be concluded that problem solving is important in learning mathematics, to develop students' thinking skills to a higher level, so that they can achieve the expected competencies. As Hudojo (2005) points out that problem solving is essential in teaching mathematics, (1) students become skilled in selecting relevant information, then analyzing it and finally examining the results, (2) intellectual satisfaction will arise from within , And (3) students' intellectual potential increases.

Although problem-solving skills are very important in mathematics teaching activities, but based on previous journals and research, it was found that the problem solving ability of high school students is still low. This is in line with Ratnaningsih's opinion (in Nur, 2014) that the skills to solve problems of solving problems of high school students or junior high school students are still low.

The low mathematical problem solving ability of students is caused by several factors, one of which is multiple intelligence (multiple intelligence). Gardner (Hoerr, 2000: 2) defines multiple intelligences as the ability to solve problems or create a product of value in society. This statement is in line with the opinion of Fleetham (2006: 11) which states that "multiple intelligences are the different skills and talents a learner uses to make products and solve problems-to demonstrate learning". Multiple Intelligence is the different abilities and talents of a student to create a product and solve problems in learning. The diversity of students' intelligence does not require a teacher to carry out individual learning activities. This statement is in accordance with the opinion of Widjajanti (2012: 2), which states that the diversity of students' intelligence should be used as a capital for a teacher to help each student to achieve their optimal performance. In line with that statement, the theory of multiple intelligences also assumes that humans basically have the ability to empower these intelligences to the max. A growing skills depends on a conducive learning environment. Learning environment can be created by teachers by applying a model or learning strategy that can facilitate students 'intelligence, So if students are involved in learning mathematics by using a model of learning that can facilitate students' intelligence will affect the ability of students in solving problems.

Therefore, the authors provide solutions one of the learning models that can facilitate students' intelligence in solving problems is PBL. Arends (1997: 156) states that PBL is one of the learning models used to improve problem-oriented high thinking level, including learning how to learn.

PBL is a learning that makes the problem as the basis for thinking for students in learning (CIDR, 2004). Problem-Based Learning is designed based on the problems of real life and is capable of impacting the mindset and attitudes of students. Problem-based learning involves students in investigation, real and relevant life situations.

Based on the above explanation, the writer is interested to describe the mathematical problem solving skills of grade X high school students based on multiple intelligences on PBL Learning. Therefore, it is necessary to do research "Analysis of Mathematical Problem Solving skills of Class X High School Students Based on Multiple Intellegence In Learning PBL"

METHOD

This research includes descriptive qualitative research type. Where is the instrument of data collection conducted in this research with written test, interview and documentation. The data collection technique used is triangulation. Triangulation technique is a data collection technique that combines from various data collection techniques and existing sources (prastowo, 2009: 289).

RESULTS AND DISCUSSION

Problem solving is a process of finding solutions to problems related to learning materials using existing knowledge. The problem-solving process provides an opportunity for students to be actively involved in studying, seeking, finding their own information to be processed into concepts, principles, theories or conclusions. According to Polya in Suherman (2003: 99) there are four main stages in the process of solving mathematical problems are: a) Understand the problem; B) Develop a plan to resolve the problem; C) Implement plans to resolve problems; D) Re-examine the results obtained (looking back).

According to Gardner (Hoerr, 2000: 2) plural intelligence as the ability to solve problems or create a product of value in society. This statement is in line with the opinion of Fleetham (2006: 11) which states that "multiple intelligences are the different skills and talents a learner uses to make products and solve problems-to demonstrate learning".Multiple intelligence is the different abilities and talents of a student to create a product and solve problems in learning. Gardner classifies multiple intelligences based on specific parts of the brain. There are nine types of intelligence expressed by Gardner (Bowles, 2008: 17), namely linguistic, musical, logical-mathematical, visual-spatial, bodily-kinesthetic, intrapersonal, interpersonal, naturalist, and existentialist. Compound intelligence in learning is the theory of multiple intelligences provides an opportunity to plan an educational program that is in accordance with the wishes of the students and the theory of multiple intelligences enables students to study different subjects and theories. Learning by applying the theory of multiple intelligences will be achieved in conditions where students are trained in facilitating the intelligences in him. This means students who do not like learning mathematics can learn through their strongest intelligence to be able to understand a mathematical material. In line with that opinion, Ula (2013: 127) states that "the student will be easy to capture the material presented by the teacher, if the material is delivered using the prominent intelligence to the student".

This is the same as stated by Sulaiman, Bahruddin, Mohamad, et al (2013: 29), ie in oneself there is at least one strongest intelligence in him.

According to Arends (1997: 156) PBL is one of the learning models used to improve problem-oriented high thinking level, including learning how to learn. The implementation of PBL has the main objectives as proposed by Christopher et al (2006): to encourage students to be self-directed in learning at higher motivation, better material memory, development in reasoning and problem-solving skills, Preferably in students from group processes and skills needs for successful collaboration. Problem Based Learning (PBL) is a learning model that can train learners to hone the ability to think mathematically. PBL-based learning consists of 5 main steps that begin with the teacher introduces learners to the problem situation and ends with the presentation and analysis of the work of the learners.
Syntax or Step-Based Problem Learning.

Stage	Activity Teachers and Learners
Stage 1	Orienting learners to the problem. The teacher explains the learning objectives and the means or logistics required. Teachers motivate learners to be actively involved in solve real or selected selected problem-solving activities
Stage 2	Organizing learners to learn. Teachers help learners define and organize learning tasks related to problems that have been oriented in the previous stage.
Stage 3	Guiding individual and group investigations. Teachers encourage learners to gather appropriate information and carry out experiments to get the clarity needed to solve the problem.
Stage 4	Develop and present the work. Teachers help learners to share assignments and plan or prepare the appropriate work as a result of problem solving in the form of reports, videos, or models.
Stage 5	Analyze and evaluate the problem-solving process. Teachers help learners to reflect or evaluate the problem-solving process

Based on the above explanation, the following will be discussed how to analyze students' mathematical problem solving abilities based on multiple intelligence on PBL learning. The first stage is the students are given preliminary tests to see the students' initial knowledge in problem-solving abilities. In the second phase, the researcher or teacher uses the PBL model in learning which consists of 5 main steps that begin with the teacher introduces the problem situation and ends with the presentation and analysis of the work of the learners. In line with that opinion, Arends (1997: 156) stated that PBL is one of the learning models used to improve problem-oriented high thinking level, including learning how to learn. Furthermore, students are given math problem solving problems. The third stage, from these results are seen various factors that affect students in solving mathematical problems of intelligence or IQ that is owned by students. Furthermore, to see the strongest intelligence that students have can be seen through the provision of a questionnaire of multiple intelligences to students, where the questionnaire contains statements containing the ninth intelligence. These statements were modified from statements compiled by McKenzie (2005: 175).Based on the questionnaire results can be known the strongest intelligences of students. In line with that opinion, Ula (2013: 127) states that "the student will be easy to capture the material the teacher submits, if the material is delivered using the prominent intelligence to the student". This is the same as stated by Sulaiman, Bahruddin, Mohamad, et al (2013: 29), ie in oneself there is at least one strongest intelligence in him. The intelligences will be used in solving math problems.

This is also supported by the results of research that has been done by kurnia hendra wijaya, sudarnim (2016) at junior level which concludes that the quality of learning problem solving of mathematics based on multiple intelligence on PBL setting is categorized well. It is seen from three aspects, namely preparation, learning process and assessment.

Based on the above description and supported by some previous relevant journals and research, it is suspected that the problem solving skills of high school students based on multiple intelligence on good categorized learning.

CONCLUSION AND SUGGESTION

Problem solving is a process of finding solutions to problems related to learning materials using existing knowledge. Multiple intelligence is the different abilities and talents of a student to create a product and solve problems in learning. PBL is a learning that makes the problem as the basis for thinking for students in learning (CIDR, 2004). Problem-Based Learning is designed based on the problems of real life and is capable of impacting the mindset and attitudes of students. Problem-based learning involves students in investigation, real and relevant life situations, so that students' mathematical problem-solving skills based on multiple intelligence on PBL learning can take place well.

Based on literature studies that have been done then the authors suggest:

1. For teachers or educators who want good problem solving skills, then see the strongest intelligence of students and PBL models one of the alternatives in the learning process.
2. For the next author who wishes to analyze students' mathematical problem solving skills based on multiple intelligence on PBL learning is suggested for other levels, such as MAN or SMK.

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ANALYSIS OF VALIDATION PRE-POST TEST MATHEMATICS LITERACY ABILITY

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Abstract

English language skills in reading, writing and communication in learning mathematics need to be improved. Mathematics literacy is an important factor in mathematics readiness and aplication. This study aims to improve students' literacy skills in understanding basic concepts, mathematical terms in English, writing definitions, theorems and translating mathematical textbooks. The type of this research is experimental research with the design is nonequivalent control group design. The mathematic literacy capability data collection was obtained by giving the test to the students. The instrument used is a matter of mathematics literacy ability test. Mathematics literacy test is given before the learning or pre-tested strategy and after the treatment or implementation of the strategy (post test). Pre-post test were based on Indicators of mathematics literacy capability and English mathematics learning plan. The steps were taken in making the pre-post test are 1) Establishing the scope of the measured subject and the timing of the test; 2) make design of draft questions; 3) Conduct self-evaluation and revise based on the results of self-evaluation; 4) Validate test questions; 5) Make a revision in accordance with the suggestion of the validator. The subject measured during the study included calculus, statistics and geometry. Making the draft matter adjusted to the lattice of mathematical literacy ability. Problems in the form of text accompanied by questions that contain indicators of literacy ability. Based on the results of validation of the question of pre-test obtained a valid question with a good category, with little revision required.

Key words: *english for mathematics literacy, questions of pre-post test, validation*

INTRODUCTION

English is a universal language that is used today, then the English language be important priority for students to learn in addition to Indonesian. Likewise in learning mathematics, English skills are needed. English for mathematics literacy learning aims to enable students to use English that has been actively studied, to understand and to plan the vocabulary of mathematical texts and textbooks, to master and skillfully communicate English in reading or related ideas in the field of mathematics both written and oral , Designing learning by using English in learning mathematics and knowing and utilizing various ways in teaching mathematics with English.

English language skills in reading and writing as well as communication between students and students with lecturers in learning math needs to be improved. The ability to read and write in mathematics is known as mathematical literacy (Mathematical Literacy). De Lange (2003) argues that mathematical literacy does not merely include the ability to execute a number of ways or procedures, and has a basic knowledge that enables a member of a society to live in a difficult situation and sufficient with only what they need but also knowledge, , and mathematical processes, which are exploited in various contexts in ways that inspire and unlock the insights of thought. Mathematical literacy is less formal but more intuitive, less abstract but more contextual, less symbolic but more concrete. Mathematical literacy focuses on reasoning, thinking, and interpretation, as well as other mathematical abilities.

To measure students' mathematical literacy skills required valid instrument. The instrument used is a test. Problem tests are given before the learning or strategy treatment is given (pre-test) and after the treatment or application of the strategy is done (post test). The question of pre-post test was made based on the Indicator of mathematical literacy capability based on the mathematics learning plan. Based on the description above, in this paper discussed the validation of the instrument, especially pre-post test.

RESEARCH METHOD

In the study of mathematics education, research methods formulated after the research problem was formulated and literature study was conducted. This research method is to determine the instrument that will be used for data collection research. Instruments used in the form of tests in the form of pre-post test. Associated with the research data, then the instrument used must be valid. To obtain valid data and can be scientifically accountable then the instrument used is validated. A valid instrument means that the instrument can measure what it wants to measure.

The instrument used is the initial test and the final test of mathematical literacy ability. The test will be used in essay form. The test material is in accordance with the material provided during the study. Test preparation steps are as follows.

1. Make a test grille.
2. Prepare the test in accordance with the grid that has been made.
3. Validate the test.

Aspek yang diamati dalam melakukan validasi soal pre-post test sebagai berikut:

Tabel 1. Aspek-aspek yang diamati dalam melakukan validasi

NN		Ada	Tidak	Penilaian			
				1	2	3	4
11	Match material with RPS						
22	The sentence used is in accordance with the rules of writing in English						
33	Problem pre-post test has been in accordance with the indicator						
44	Problem pre-post tests in accordance with student ability and easy to understand						

Validation result to all observed aspect, presented in tabular form, then searched average score using formula:

$$R = \frac{\sum_{j=1}^{n} V_{ji}}{nm}$$

with
R the average result of the assessment from the experts / validator

V_{ji} : score of the j th expert / practitioner's assessment of the i-th criterion
n : the number of experts / practitioners who judge
m : number of criteria
The average obtained is confirmed by the specified criteria. How to get the criteria is to set a range of scores ranging from 1 (sr = low score) to 4 (st = high score). The range of scores is divided into five interval classes. Criteria for each interval are categorized into four levels as in Table 1.

Tabel 2. Instrument Validity Criteria and Worksheet

Rerata (R)	Kriteria
3,00 < R ≤ 4,00	Valid
2,00 < R ≤ 3,00	Cukup Valid
1,00 < R ≤ 2,00	Kurang valid
0,00 < R ≤ 1,00	Tidak valid

(Modifikation of Arikunto, 2010: 270-272)

This study was conducted only until the validation stage of the instrument in the form of pre-post test.

RESULT AND DISCUSSION

Research carried out at this stage is preparing the Instrument. The instrument used is a test. The test used is a matter of pre-post test. The question of pre-post test consists of a set of test questions to measure the ability of mathematical literacy. Matter of Mathematical Literacy Test is given prior to learning or pre-tested strategy and after treatment or implementation of the strategy (post test). Problem Pre-post test is made based on the material presented the ability of mathematical literacy which is compiled based on the plan of learning English mathematics. The steps taken in making the pre-post test questions are 1) Establishing the scope of the measured material and the timing of the test; 2) Designing draft questions; 3) Conduct self-evaluation and revise based on the results of self-evaluation; 4) validate test questions; 5) Make a revision in accordance with the suggestion of the validator.

1) Setting the coverage of the measured material

The material measured during the study included calculus, statistics and geometry. After determining the scope of the material measured, a mathematical literacy trap indicator was prepared. The details of mathematical indicators are arranged in accordance with RPS and SAP which will be measured as follows:

Tabel 6 Detailed Literacy Capability Indicator

No	Aspects Literacy Capability Literacy Indicators	Literacy Capability Indicator
1	*Communication*	Students are able to translate reading material in English into Indonesian
2	*Mathematising*	Students are able to expose the term into the language of mathematics
3	*Representation*	Students are able to translate the problem using graphs, tables, drawings, formulas and others so that the problem is more clear

1) Designing draft questions

Based on materials and literacy literacy indicators draft about the pre-post test. The essay-shaped question consisted of reading English text and accompanied by questions in accordance with each indicator.

A point is an exact location in space. A point is denoted by a dot. A point has no size. As for a line segment, we specify a line with two endpoints. Starting with the corresponding line segment, we find other line segments that share at least two points with the original line segment. In this way we extend the original line segment indefinitely. The set of all possible line segments findable in this way constitutes a line. A line extends indefinitely in a single dimension. Its length, having no limit, is infinite. Like the line segments that constitute it, it has no width or height. You may specify a line by specifying any two points within the line. For any two points, only one line passes through both points. On the other hand, an unlimited number of lines pass through any single point. A point exists in zero dimensions. A line exists in one dimension, and we specify a line with two points. A plane exists in two dimensions. We specify a plane with three points. Any two of the points specify a line. All possible lines that pass through the third point and **any** point in the line make up a plane. In more obvious language, a plane is a flat surface that extends indefinitely in its two dimensions, length and width. A plane has no height.

Exercises

Q1: Base on text, what is the characteristic of line?

A1: 1. The line have length

2. Having no limits

3. Infinite

4. No width or height

Q2: Can you explain how to specify a plane?

Figure 4. Draft Problem Pre-post literacy capability test with Geometry material

Geometry problem consists of one essay with two questions. Selected material about point, line, field and space.

2) Conduct self-evaluation and revise based on the results of self-evaluation

Self-evaluation is done by discussing the research team to analyze the pre-post test that has been prepared based on the indicatr. Results of discussion and analysis of the problem obtained the conclusion that the problem of pre-post test has not fulfilled the literacy ability indicator. After performing self-evaluation of the pre-post test problem, it will be repaired. Futhermore give an example of a problem that has been fixed.

Soal
1. A point is an exact location in space, it is denoted by a dot. It has no size. As for a line segment, we specify a line with two endpoints. Starting with the corresponding line segment, we find other line segments that share at least two points with the original line segment. In this way we extend the original line segment indefinitely. The set of all possible line segments findable in this way constitutes a line. A line extends indefinitely in a single dimension. Its length, having no limit, is infinite. Like the line segments that constitute it, it has no width or height. You may specify a line by specifying any two points within the line. For any two points, only one line passes through both points. On the other hand, an unlimited number of lines pass through any single point. A point exists in zero dimensions. A line exists in one dimension, and we specify a line with two points. A plane exists in two dimensions. We specify a plane with three points. Any two of the points specify a line. All possible lines that pass through the third point and **any** point in the line make up a plane. In more obvious language, a plane is a flat surface that extends indefinitely in its two dimensions, length and width. A plane has no height. **Exercises** 1. Translate a text above! 2. Q1: Base on text, what is the characteristic of line? and draw a line! A1: 1. The line have length 2. Having no limits 3. Infinite 4. No width or height Q2: Can you explain how to specify a plane? And draw the planes that contains three points, four point and five points! A2: We can specify a plane by make a line between at least three points, which is for any two points only one line pass through.

Figure 5. Example Draft Problem Pre-post literacy capability test with Geometry material

Geometry problem consists of one essay with two Exersice. Selected material about point, line, field and space. After the self-evaluation question was asked plus one question to bring up the indicator commucation and the second question was revised because it has not met the repsentation indicator.

3) Conducting test validation

Validation about literacy ability is done by two experts. Based on the validation results obtained that the matter declared vaild and need a little revised.

CONCLUSIONS AND RECOMMENDATIONS

The question of pre-post test is made based on indicator of mathematical literacy ability. The steps taken in making the pre-post test questions are 1) Establishing the scope of the measured material and the timing of the test; 2) Designing draft questions; 3) Conduct self-evaluation and revise based on the results of self-evaluation; 4) validate test questions; 5) Make a revision in accordance with the suggestion of the validator. The validation result states that the resource and the question are valid with little revision. This research is suggested to proceed at a later stage.

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ANALYSIS OF DIVIDEND AND STOCK PRICE FOR COMPANIES LISTED IN IDX LQ45

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Abstract

Dividend and stock price are indicators investment in stock market. A dividend is a payment made by a corporation to its shareholders, usually as a distribution of profits. While, a closing price represent a performance company in the stock market. Analysis of both variables is started by describing of them and it is used descriptive statistics. After that, checking relationship and modelling dividend and closing price with many financial variables. The variables are; Profit (X1), Revenues (X2), Liabilities (X3), Capital (X4), Total Asset Turnover (X5), Return on Equity (ROE; X6), Expenses (X7), Net profit Margin (X8), Debt to Asset Ratio (DAR; X9), Dividend (X10), Closing Price (X11), Book Value per Share (BV;X12) and Debt Equit Ratio (DER;X13). This paper investigate the separate but simultaneous impact of firm characteristic on dividend and closing price by used path analysis. The result analysis shows that a highly significant and positive size effect between variables.

Keyword: *dividend, closing price, stock market, descriptive statistics, path analysis*

INTRODUCTION

Investments in companies are aimed to obtaining stock price returns. The return can be either capital gains or dividends. Dividends are net revenues after taxes and retained earnings. Dividends can also be interpreted as compensation received by shareholders as a profit of the company. The return on investment in the form of dividend is not easy to predict. This is due to dividend policy is a difficult and dilemmatic policy for the management company. Company decisions regarding dividends are sometimes integrated with funding decisions and investment decisions. Low dividends may be because management is very concerned about the survival of the company, making retained earnings to make expectations or require cash for the company's operations.

Stock price fluctuations are a stock market reaction to a product, so stock price changes are more to external influences for the company. Investors expect capital gain from the stock. is the excess of the selling price over the purchase price of the stock. Dividend is one of the causes of the emergence of investment in the capital market. Investors prefer dividends rather than capital gains, this is because dividends are a more definite acceptance than capital gains. It is therefore very interesting to examine what financial factors affect to dividends and stock prices (as measured by closing prices). The analysis used in this research is path analysis. This analysis can explain the variables that directly and indirectly influence the dividend policy and stock price.

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Path Analysis

Path analysis is often also called the causal models for directly observed variabels. Basically path analysis is the development of regression analysis and it is used to analyze the causal relationship between variables. In addition, path analysis aims to determine the direct effect and indirect effect of a (independent) exogenous variable to the dependent variables (endogenous)variables. The equations that show the structured relationship of each endogenous variable with some exogenous variables are called structural equations and diagrams which represent them called path diagrams.

Assumptions on path analysis:

1. The relationship between exogenous variables with endogenous variables are linear
2. The direction of the effect of causality of exogenous variables on endogenous variables is only one direction.
3. All variables are numeric
4. All the variables used can be observed directly
5. The model is built on a particular theoretical framework and is able to explain the causality relationship between the variables studied.

In the following will be given the most simple diagram of the path diagram. In the digram is exemplified endogenous variable X_2 will be influenced directly by exogenous variable X_1. In addition to X_1 there is another variable affecting X_2, but this variable is not observed, this variable is called the residual variable and is denoted by ε.

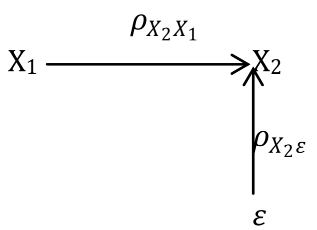


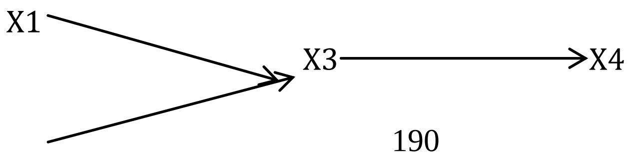
Figure 1. Path Diagram X_2 and X_2

The structural equation for Figure 1 is $X_2 = \rho_{X_1X_2}X_1 + \varepsilon$,

where $\rho_{X_2X_1}$= Path coefficient between exogenous variables X_1 on endogenous variables X_2

$\rho_{X_2\varepsilon}$= Path coefficient between residual ε on endogenous variables X_2.

In Figure 2 will be described two structural relationships. First, the substructural expressing the causal relationships of X_1 and X_2 to X_3, as well as the second substructure suggests a causal relation from X3 to X4. In the first substructure, X_1 and X_2 are exogenous and X_3 as endogenous variables. In the second substructure, X_3 is an exogenous variable and X_4 is the endogenous variable.



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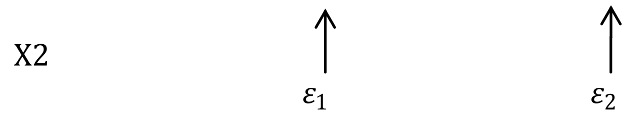

Figure 2. Path Diagram for two structural relationships between X_1, X_2, X_3 and X_4

The structural equation for Figure 2 are:

$$X_3 = \rho_{X_3X_1}X_1 + \rho_{X_3X_2}X_2 + \rho_{X_3\varepsilon_1}\varepsilon_1 \; and \; X_4 = \rho_{X_4X_3}X_3 + \rho_{X_4\varepsilon_2}\varepsilon_2$$

RESEARCH METHODS

The data used in this study is the data of companies listed in LQ45, Indonesia Stock Exchange, based on data in December 2015 and taken from the financial report of Indonesia Stock Exchange in August 2016.

Analysis of dividend and closing price ar started by describing of them and it is used descriptive statistics. After that, checking relationship and modelling dividend and closing price with many financial variables. The variables are; Profit (X1), Revenues (X2), Liabilities (X3), Capital (X4), Total Asset Turnover (X5), Return on Equity (ROE; X6), Expenses (X7), Net profit Margin (X8), Debt to Asset Ratio (DAR; X9), Dividend (X10), Closing Price (X11), Book Value per Share (BV;X12) and Debt Equit Ratio (DER;X13). This paper investigate the separate but simultaneous impact of firm characteristic on dividend and closing price by used path analysis.

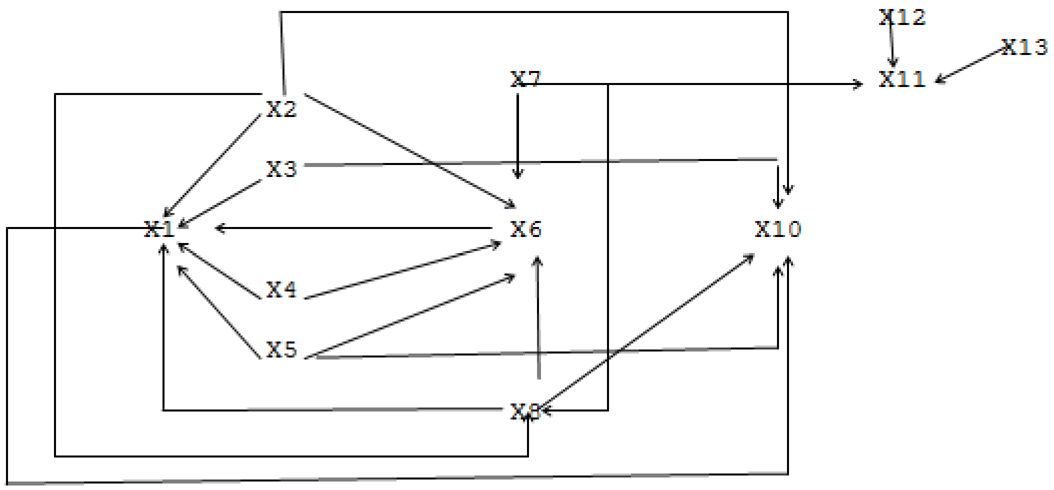

Figure 3. Path Diagram of Conceptual Framework of Research

The conceptual framework is the rationale of synthesized research from facts, observations and literary studies. In accordance with the general financial management function, the dividend payout aims to maximize shareholder wealth or stock prices. Based on the facts from the literature review, the conceptual framework of this research is described in Figure 3.

The structural equations of Figures are:

$$X_1 = \rho_{X_1X_2}X_2 + \rho_{X_1X_3}X_3 + \rho_{X_1X_4}X_4 + \rho_{X_1X_5}X_5 + \rho_{X_1X_6}X_6 + \rho_{X_1X_8}X_8 + \rho_{X_1\varepsilon_1}\varepsilon_1$$

$$X_6 = \rho_{X_6X_2}X_2 + \rho_{X_6X_4}X_4 + \rho_{X_6X_5}X_5 + \rho_{X_6X_7}X_7 + \rho_{X_6X_8}X_8 + \rho_{X_6\varepsilon_2}\varepsilon_2$$

$X_8 \;=\; \rho_{X_8 X_2} X_2 + \rho_{X_8 X_7} X_7 + \; \rho_{X_8 \varepsilon_3} \varepsilon_3$
$X_{10} \;=\; \rho_{X_{10} X_1} X_1 + \; \rho_{X_{10} X_2} X_2 + \; \rho_{X_{10} X_3} X_3 + \; \rho_{X_{10} X_5} X_5 + \; \rho_{X_{10} X_6} X_6 + \; \rho_{X_{10} \varepsilon_4} \varepsilon_4$
$X_{11} \;=\; \rho_{X_{11} X_7} X_7 + \rho_{X_{11} X_{12}} X_{12} + \rho_{X_{11} X_{13}} X_1 + \; \rho_{3 X_{11} \varepsilon_5} \varepsilon_5$

RESULT AND ANALYSIS

Of the 45 companies listed on LQ 45 there are 2 companies whose profits are negative, the company is excluded from the analysis, because it has poor performance. Therefore, only 43 companies were analyzed

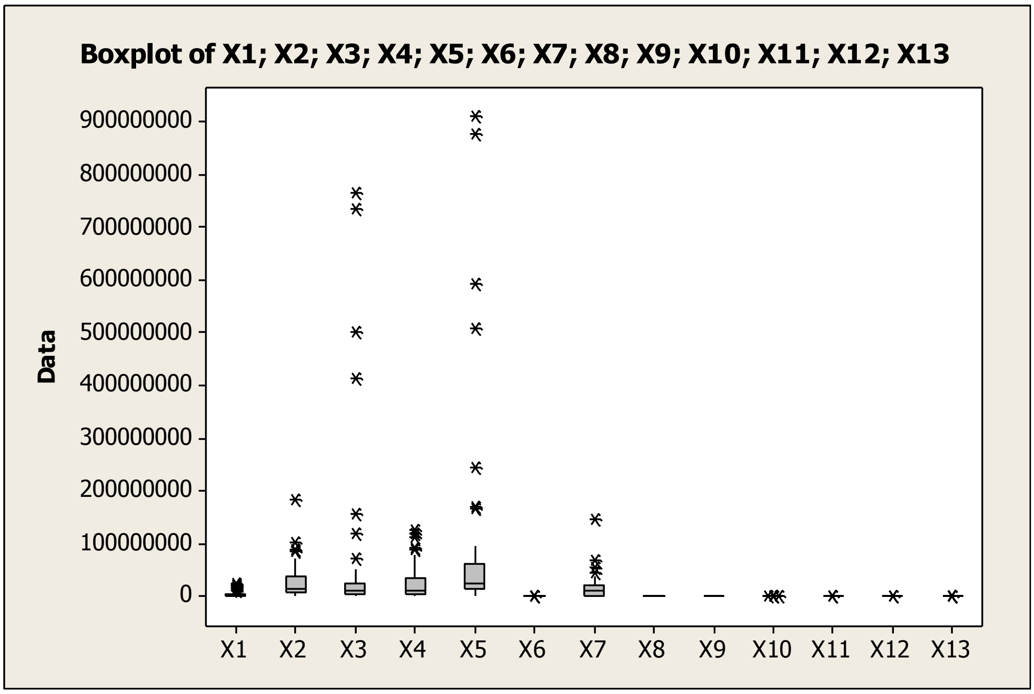

Figure 4. The Box-Plot Diagram for all Variables (Original Data)

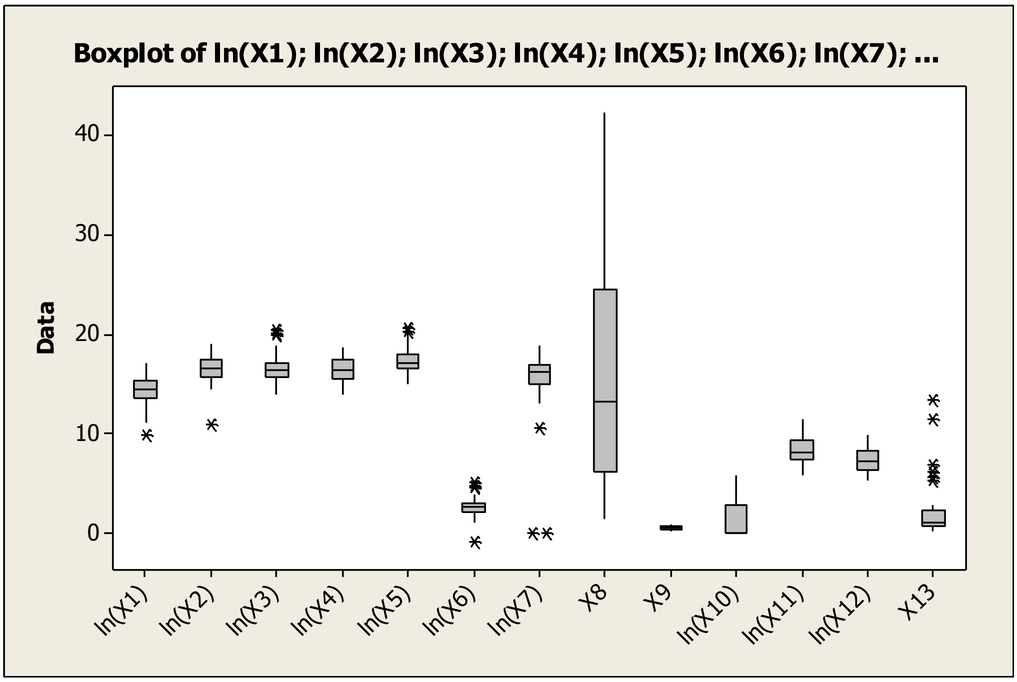

Figure 5. The Box-Plot Diagram for all Variables (Transformed Data)

The first section will explain general information about the data. The presentation use box-plot diagram in Figure 4. The diagram shows that most of variables not homogenous, and the values are very varied, some are millions and some are a decimal only, therefore variables whose value is too large to be transformed. The box-plot diagram of Figure 5 illustrates data after transformation and it shows that all variables are homogeneous. Linear relationship between exogenous variables and endogenous variable are presented in appendices. The Figures show that linear assumptions between variables are met.

There are four (4) path diagrams and structural equations are proposed in this study. The results are shown in Table 1 and Table 2. The result of the estimation of structural equation, the value of R2 and its residual are given by Table 1. While Table 2 shows the amount of direct and indirect relationship between variables.

The best model is the first model, which explains the relationship of capital (X4) and return on equity (X6) to profit (X1). The value of R2 is almost 100%, ie 99.9%, meaning 99.9% variation of profit (X1) can be explained ole X4 and X6. The second best model is the fouth model, it expalin relationship between BV(X12) with closing price. The value of R2 is 46%. The third best model explain relationship liabilities (X3) with dividend, the R2 value is 21.1%. The others model are revenues(X2) with return on equity (X6) (R2=16.6%) and revenues (X2) with net profit margin (X8) (R2=10.7%). The magnitude of the direct and indirect effects between variables is shown in Table 2. Only Profit (X1) variables, which have an indirect effect.

Table 1. Structural Equations, R2 and Residual

Structural Equations	R^2	Residual
$LnX_1 = 0{,}835\, LnX_4 + 0{,}662\, LnX_6 + \rho_{X_1\varepsilon_1}\varepsilon_1$	0,999	0,031
$LnX_6 = 0{,}407 LnX_2 + \rho_{X_6\varepsilon_2}\varepsilon_2$	0,166	0,913
$X_8 = -0{,}326\, LnX_2 + \rho_{X_8\varepsilon_3}\varepsilon_3$	0,107	0,945
$X_{10} = 0{,}458 LnX_3 + \rho_{X_{10}\varepsilon_4}\varepsilon_4$	0,210	0,889
$LnX_{11} = 0{,}678 LnX_{12} + \rho_{3X_{11}\varepsilon_5}\varepsilon_5$	0,460	0,735

Table 2. Path Diagram and Effects

Path	Direct and Indirect Effects
LnX2 → LnX8 LnX2 → LnX6 → LnX1 LnX4 → LnX1	LnX2 direct effect to Ln X8 is -0,326 LnX2 direct effect to LnX6 is 0,407 Ln X6 direct effect to LnX1 is 0,662 LnX2 inndirect effect to LnX1 is (0,407x0,6622)=0,270 Total effect to LnX1 is 0,662+0,270=0,932 LnX4 direct effect to LnX1 is 0,835
LnX3 → X10	LnX3 direct effect to X10 amount 0,458
LnX12 → LnX11	LnX12 direct effect to LnX11 amount 0,678

CONCLUSIONS

After analyzing the data by using path analysis, it can be concluded that there is only one variable affecting dividend is liabilities and only one variable that influence closing price that is Book to Value (BV). Both of these variables (Liabilities and BV) are not modeled with other variables, therefore there is no indirect effect on dividend and closing price. Some hypothesized variables affect to the dividend and closing price are not significant.

Another structural model is the capital and return on equity to profit, both have a direct relationship with profit. However profit has no relationship with dividend and closing price.Return on equty is influenced by revenues, therefore revenues indirectly affected to Profit. In addition, revenues directly affect net profit margin

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APPENDICES

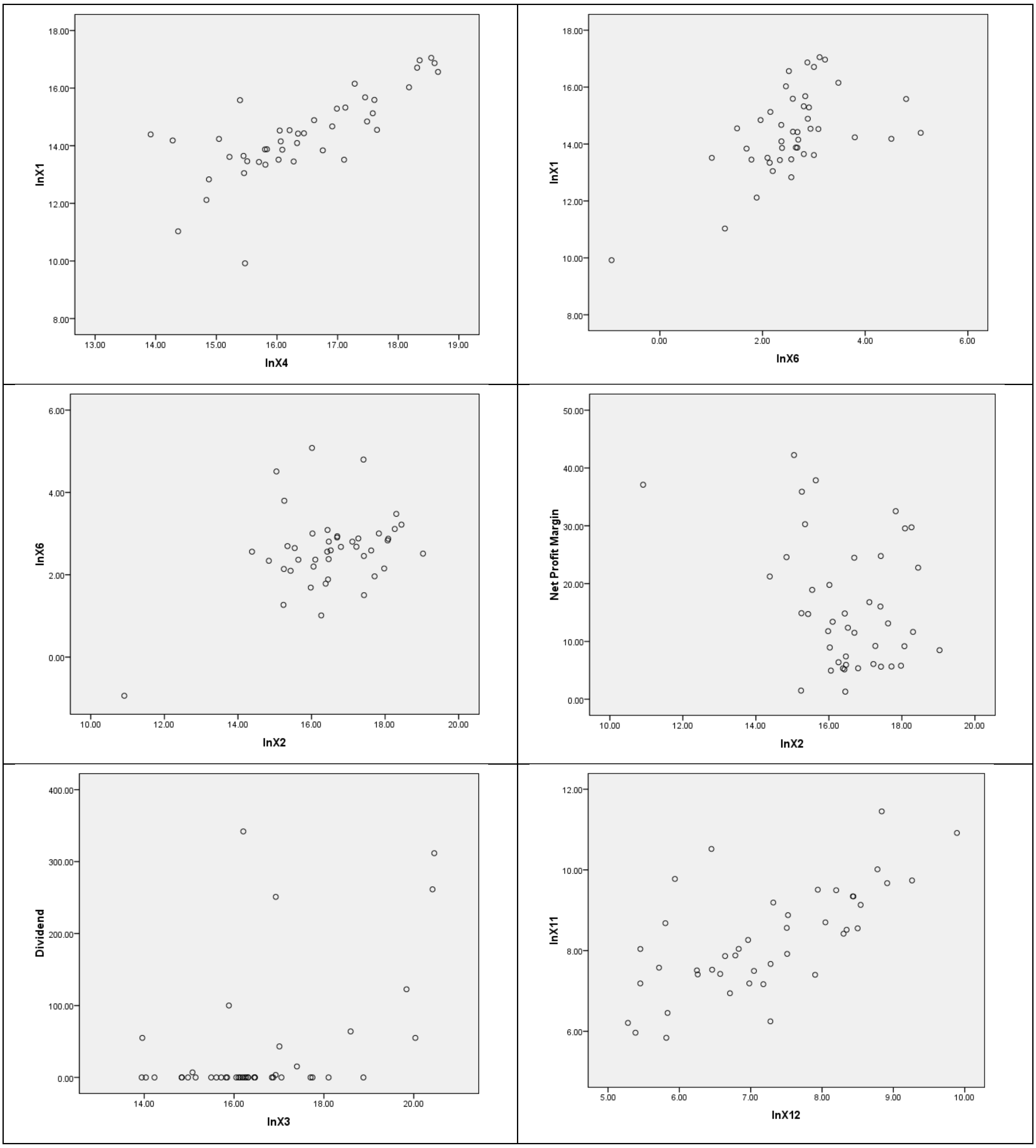

Figure 1. Scatter Plot Between Exogenous Variables and Endogenous Variables

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WRONSKIAN ON SYSTEM OF LINEAR DIFFERENTIAL EQUATION

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Abstract

Solution of linearly differential equation is a linear combination of solutions, called general solution. Each solution construct general solution which is linearly independent. For example, differential equation of order-2,

$$a_0(x)y" + a_1(x)\, y' + a_2(x)\, y = f(x)$$

With general solution:

$$y(x) = C_1y_1(x) + C_2y_2(x)$$

forwhich $y_1(x)$ and $y_2(x)$ are independently functions.
Linear independent property of linear differential equation of order-2 is also do for order-n, which can be check using Wronskian. System of Linear Differential Equation (SLDE) is a system of some related differential equations. Solution of SLDE is a function which fulfill the SLDE which a family of curves. It gives a question, how it linear independent property and Wronskian form for SLDE? Function of it research are:1) determine solution of system of linear deferential equation of order-1, 2)determine Wronskian form in system of linear differential equation of order-n, and 3) discuss Wronskian and and linear independent property of solutions of SLDE of order-1.

System of Linear Differential Equation of order-1

$$\frac{dy_i}{dx} + \sum_{j=1}^{n} a_{ij}\,(x)y_j = f_i(x)\,,\;\; i = 1\,,2\,,\ldots,n$$

haven solutions,y_1 , y_2 , ... , y_n for which:

$$y_j\,(x) = \begin{bmatrix} y_{1j}\,(x) \\ y_{2j}\,(x) \\ \vdots \\ y_{nj}\,(x) \end{bmatrix}$$

with Wronskian of solutions is:

$$W = \begin{vmatrix} y_{11}(t) & y_{12}(t) & \cdots & y_{1n}(t) \\ y_{21}(t) & y_{22}(t) & \cdots & y_{2n}(t) \\ \vdots & \vdots & \cdots & \vdots \\ y_{n1}(t) & y_{n2}(t) & \cdots & y_{nn}(t) \end{vmatrix}$$

By check Wronskian of solutions of differential equation system, we reach solutions of fundamental set constructor which is linearly independent if the Wroskian is not equal to zero.

Keywords: *Wronskian, Solutions of Differential Equation System, Linearly Independent*

INTRODUCTION

Differential equation is equation contains derivatives (one or some) of an unknown function. Differential equation are often use in modelling the real problem for several area.

General form of linear differential equation of order-n is:

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \ldots + a_{n-1}(x)y' + a_n(x)y = f(x)$$

with function f is continuous on its domain.

A function called solution of a differential equation if it fulfill the differential equation itself. Let f is solution of differential equation,

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \cdots + a_{n-1}(x)y' + a_n(x)y = 0$$

so:

$$a_0(x)f^{(n)} + a_1(x)f^{(n-1)} + \cdots + a_{n-1}(x)f' + a_n(x)f = 0$$

Let $f_1, f_2, \ldots, f_n$ are nfunctions which are solutions of a differential equation, where its derivatives until the (n-1)th derivatives continuous in an interval.

Wronskian of$f_1, f_2, \ldots, f_n$ which is calculated on x, is:

$$W(f_1, f_2, \ldots, f_n; x) = \begin{vmatrix} f_1 & f_2 & \ldots & f_n \\ f_1' & f_2' & \cdots & f_n' \\ \vdots & \vdots & \ldots & \vdots \\ f_1^{(n-1)} & f_1^{(n-1)} & \cdots & f_1^{(n-1)} \end{vmatrix}$$

Wronskian is used to check if the differential equation solution, linearly independent of not. If each solution linearly independent, so the general solution can be construct as linear combination of it solutions.

Some problem in the real world when formulated into mathematical model, fulfill equations which contains one or more derivatives of unknown function. In other case, we find the mathematical model contains two or more unknown function, such that it construct a system of equation, which is system of differential equation.

General form of system of linear differential equation of order-1 is:

$$\frac{dy_1}{dx} + a_{11}(x)y_1 + a_{12}(x)y_2 + \cdots + a_{1n}(x)y_n = f_1(x)$$
$$\frac{dy_2}{dx} + a_{21}(x)y_1 + a_{22}(x)y_2 + \cdots + a_{2n}(x)y_n = f_2(x)$$
$$\vdots$$
$$\frac{dy_n}{dx} + a_{n1}(x)y_1 + a_{n2}(x)y_2 + \cdots + a_{nn}(x)y_n = f_n(x)$$

and can be write as follows

$$\frac{dy}{dx} + A(x)y = f(x)$$

A system of differential equation can be approximate by construct a similar differential equation and also it solution. It gives a question, how to construct Wronskian form so we know the linear independent property among solution of differential equation system.

THEORETICAL FRAMEWORK

Basic concept in discussing Wroskian on system of linear differential equation is:

1. Differential Equation

Differential Equation is an equation which fulfill derivatives of a functions with one or more independent variables. Differential equation contains dependent variables and it derivatives subject to independent variable. Ordinary differential equation is differential equation with one independent variable. Partial differential equation is a differential equation having a dependent variables with two or more independent variables.

Ordinary differential equation of order-n with dependent variable y and independent variable x, is equation in the form:

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \ldots + a_{n-1}(x)y' + a_n(x)y = f(x)$$

Where $a_0, a_1, \ldots a_n$ and f is real continuous on interval $a \le x \le b$, is called non-homogeneous differential equation.

If $f(x) = 0$, so

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \ldots + a_{n-1}(x)y' + a_n(x)y = 0$$

and called homogeneous differential equation.

2. Solution of Differential Equation

Solution of a differential equation is an important topic in differential equation case. Solution of a differential equation is a function which fulfill variables of differential equation and fulfill the given differential equation. If f(x) is a solution of differential equation, so f(x) and it derivatives will also fulfill it differential equation.

A function is called solution of differential equation, if it fulfill that equation. Let f is solution of differential equation,

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \cdots + a_{n-1}(x)y' + a_n(x)y = 0$$

so,

$$a_0(x)f^{(n)} + a_1(x)f^{(n-1)} + \cdots + a_{n-1}(x)f' + a_n(x)f = 0$$

is solution of differential equation and family of functions on XY-plane.

Each function of the curves family are special solution of differential equation by giving a value for constant k. Graph of function of differential equation solution which is family of curves, are not in touch one and other.

General solution of differential equation of order-n is a function contains all solution. For general, general solution of ordinary differential equation of order-n contains n unknown constant (where constant c is a real number).

Homogeneous differential equation of order-n

$$a_0(x)y^{(n)} + a_1(x)y^{(n-1)} + \cdots + a_{n-1}(x)y' + a_n(x)y = 0$$

If $f_1, f_2, \ldots, f_n$ are independent solution, so solution of it differential equation is linear combination

$$c_1f_1 + c_2f_2 + \cdots + c_nf_n$$

With $c_1, c_2, \ldots, c_n$ are constant.

On determine the solution of differential equation we have to know it equation form. To solve the non-homogeneous linear differential equation, we need it discuss about it homogeneous equation. To reach it, we can use order reduction method, which makes the order of differential equation reduce as number of reduction.

Homogeneous solution of linear differential equation of order-n, shows as y_h with the following:

Theorem 1:

Let $y_1, y_2, \cdots, y_n$ are n solution of homogeneous linear differential equation, so it solution is:

$$y_h = c_1y_1(x) + c_2y_2(x) + \cdots + c_ny_n(x)$$

For $c_1, c_2, \cdots, c_n$ are constants.

3. Wronskian on Differential Equation

Determinantform

$$\begin{vmatrix} y_{11}(x) & y_{11}(x) & \cdots & y_{1n}(x) \\ y_{21}(x) & y_{22}(x) & \cdots & y_{2n}(x) \\ \vdots & \vdots & & \vdots \\ y_{n1}(x) & y_{n2}(x) & \cdots & y_{nn}(x) \end{vmatrix}$$

Is called Wronskian of collection of vector functions

$$y_1(x) = \begin{bmatrix} y_{11}(x) \\ y_{21}(x) \\ \vdots \\ y_{n1}(x) \end{bmatrix}, \ldots, y_n(x) = \begin{bmatrix} y_{1n}(x) \\ y_{2n}(x) \\ \vdots \\ y_{nn}(x) \end{bmatrix}$$

Related to solution of differential equation, Wronskian is defined as follows.

Definition 1:

Let $f_1, f_2, \ldots, f_n$ are $n$solution of homogeneous linear differential equation
Wronskian of$f_1, f_2, \ldots, f_n$calculated on x is

$$W(f_1, f_2, \ldots, f_n\ ;\ x) = \begin{vmatrix} f_1 & f_2 & \cdots & f_n \\ f_1' & f_2' & \cdots & f_n' \\ \vdots & \vdots & \cdots & \vdots \\ f_1^{(n-1)} & f_1^{(n-1)} & \cdots & f_1^{(n-1)} \end{vmatrix}$$

Linear independently of n solutions on homogeneous solution can be seen from it Wronskian.

Theorem 2:

If $f_1, f_2, \dots, f_n$ linear independent function are solution of homogeneous differential Wronskian of $f_1, f_2, \dots, f_n$ calculated on x is

$$W(f_1, f_2, \dots, f_n\ ;\ x) = \begin{vmatrix} f_1 & f_2 & \cdots & f_n \\ f_1{}' & f_2{}' & \cdots & f_n{}' \\ \vdots & \vdots & \cdots & \vdots \\ f_1{}^{(n-1)} & f_1{}^{(n-1)} & \cdots & f_1{}^{(n-1)} \end{vmatrix} \neq 0$$

4. System of Differential Equation

n differential equation which is related on an other will construct a system called system of differential equation. System of differential equation is group based on it equation form, is linear equation system and system of non-linear equation.

System of first order linear equation are as follows:

$$\frac{dx}{dt} = Ax \dot{+} b(t)$$

Where A is coefficient matrices order $n \times n$ and $b(t)$ is a continuous function. It system is called system of linear differential equation of order-1. If $b(t) = 0$, the system is called homogeneous and if $b(t) \neq 0$, the system is non-homogeneous.

A solution of first order of differential equation system

$$\frac{dx}{dt} = A(t)x + F(t)$$

is a vector function,

$$\phi = \begin{pmatrix} \phi_1 \\ \phi_2 \\ \vdots \\ \phi_n \end{pmatrix}$$

for $\phi_1, \phi_2, \dots, \phi_n$ having continuous derivatives on interval $a \leq t \leq$ such that ,

$$\frac{d\phi(t)}{dt} = A(t)\phi(t) + F(t)$$

METHOD

Methods using in this research is literature review, theory which is found are described. Relevant theory and analyzed are write in the defenition or theorem form. Research are startedwith study the problem, collect and relate the relevant theory into problem such that it solved. Research work flow are as follows:

1. Collecting the relevant theory with Wronskian problem on linear differential equation.
2. Describe/analyse solution on system of differential equation of order-1
3. Describe/analyse solution and Wronskian on system of differential equation of order-1
4. Conclude the Wronskian on system of linear differential equation.

RESULT AND DISCUSSION

Consider form of linear system of n first-order differential equation in n unknown function $x_1, x_2, \dots, x_n$:

$$\begin{aligned}\frac{dx_1}{dt} &= a_{11}(t)x_1 + a_{12}(t)x_2 + \cdots + a_{1n}(t)x_n + F_1(t)\\ \frac{dx_2}{dt} &= a_{21}(t)x_1 + a_{22}(t)x_2 + \cdots + a_{2n}(t)x_n + F_2(t)\\ &\vdots\\ \frac{dx_n}{dt} &= a_{n1}(t)x_1 + a_{n2}(t)x_2 + \cdots + a_{nn}(t)x_n + F_n(t)\end{aligned} \tag{1}$$

We shall assume$a_{ij}(t),\ i = 1,2,\dots,n, \quad j = 1,2,\dots,n$
and$F_i(t),\quad i = 1,2,\dots,n$, are continuous on a real interval$a \le t \le b$.
If all $F_i(t) = 0,\ i = 1,2,\dots,n,$ for all$t$, then the system (1) is call homogeneous. Otherwise, is called non-homogeneous.

The system (1) can be written as:

$$\frac{dx_i}{dt} = \sum_{j=1}^{n} a_{ij}(t)x_j + F_i(t)(i = 1,2,\dots,n).$$

Introduce the matrix **A**defined by:

$$\mathbf{A}(t) = \begin{pmatrix} a_{11}(t) & a_{12}(t) & \cdots & a_{1n}(t)\\ a_{21}(t) & a_{22}(t) & \cdots & a_{2n}(t)\\ \vdots & \vdots & & \vdots\\ a_{n1}(t) & a_{n2}(t) & \dots & a_{nn}(t)\end{pmatrix} \tag{2}$$

and the vector **F** and**x** defined by:

$$\mathbf{F}(t) = \begin{pmatrix} F_1(t)\\ F_2(t)\\ \vdots\\ F_n(t)\end{pmatrix} \quad \text{dan } \mathbf{x} = \begin{pmatrix} x_1\\ x_2\\ \vdots\\ x_n\end{pmatrix} \tag{3}$$

By definition of derivative of vector, system (1) defined:

$$\frac{d\mathbf{x}}{dt} = \begin{pmatrix} \frac{dx_1}{dt}\\ \frac{dx_2}{dt}\\ \vdots\\ \frac{dx_n}{dt}\end{pmatrix}$$

System (1) can be expression as the linear vector differential equation

$$\frac{d\mathbf{x}}{dt} = \mathbf{A}(t)\mathbf{x} + \mathbf{F}(t) \tag{4}$$

Definition 1:

Solution of the vector differential equation (4) we mean an $n \times 1$ colomn vector

$$\boldsymbol{\phi} = \begin{pmatrix} \phi_1\\ \phi_2\\ \vdots\\ \phi_n\end{pmatrix} \tag{5}$$

whose component$\phi_1, \phi_2, \dots, \phi_n$ each have a continuous derivative on the real interval $a \le t \le b$, such that

$$\frac{d\boldsymbol{\phi}(t)}{dt} = \mathbf{A}(t)\boldsymbol{\phi}(t) + \mathbf{F}(t) \tag{6}$$

for all t such that $a \leq t \leq b$.
In other word, $\mathbf{x} = \boldsymbol{\phi}(t)$ satisfies the vector differential equation (4).

Component $\phi_1, \phi_2, \dots, \phi_n$ of $\boldsymbol{\phi}$,

$$\begin{aligned} x_1 &= \phi_1(t), \\ x_2 &= \phi_2(t), \\ &\vdots \\ x_n &= \phi_n(t), \end{aligned} \tag{7}$$

satisfies$n$ equation ofsystem (1) of vector differential equation (4).

Theorem 1:

A linear combination of m solutions of the homogenuous vector differential equation:

$$\frac{d\mathbf{x}}{dt} = \mathbf{A}(t)\mathbf{x}$$

also solution..

If the vector function$\boldsymbol{\phi}_1, \boldsymbol{\phi}_2, \dots, \boldsymbol{\phi}_m$ are$m$ solution of (4) dan $c_1, c_2, \dots, c_m$ are m number, then the vector function

$$\boldsymbol{\phi} = \sum_{k=1}^{m} c_k \boldsymbol{\phi}_k$$

is also solution (4).

Proof:

We have,

$$\frac{d}{dt}\left[\sum_{k=1}^{m} c_k \boldsymbol{\phi}_k(t)\right] = \sum_{k=1}^{m}\left[\frac{d}{dt} c_k \boldsymbol{\phi}_k(t)\right] = \sum_{k=1}^{m} c_k \left[\frac{d\boldsymbol{\phi}_k(t)}{dt}\right]$$

Since each$\boldsymbol{\phi}_k$is a solution of (4),

$$\frac{d\boldsymbol{\phi}_k(t)}{dt} = \mathbf{A}(t)\boldsymbol{\phi}_k(t)$$

for$k = 1,2, \dots, m$

Then:

$$\frac{d}{dt}\left[\sum_{k=1}^{m} c_k \boldsymbol{\phi}_k(t)\right] = \sum_{k=1}^{m} c_k \mathbf{A}(t)\, \boldsymbol{\phi}_k(t)$$

$$\sum_{k=1}^{m} c_k \mathbf{A}(t)\boldsymbol{\phi}_k(t) = \sum_{k=1}^{m} \mathbf{A}(t)[c_k \boldsymbol{\phi}_k(t)] = \mathbf{A}(t)\sum_{k=1}^{m} c_k \boldsymbol{\phi}_k(t)$$

We have,

$$\frac{d}{dt}\left[\sum_{k=1}^{m} c_k \boldsymbol{\phi}_k(t)\right] = \mathbf{A}(t)\left[\sum_{k=1}^{m} c_k\, \boldsymbol{\phi}_k(t)\right]$$

that is

$$\frac{d\boldsymbol{\phi}(t)}{dt} = \mathbf{A}(t)\boldsymbol{\phi}(t)$$

Thus the linear combination

$$\phi = \sum_{k=1}^{m} c_k \phi_k$$

is also solution (4) ■

Let $\phi_1, \phi_2, \dots, \phi_n$ be the n vector functions

$$\boldsymbol{\phi}_1(t) = \begin{pmatrix} \phi_{11}(t) \\ \phi_{21}(t) \\ \vdots \\ \phi_{n1}(t) \end{pmatrix}, \boldsymbol{\phi}_2(t) = \begin{pmatrix} \phi_{12}(t) \\ \phi_{22}(t) \\ \vdots \\ \phi_{n2}(t) \end{pmatrix}, \dots \boldsymbol{\phi}_n(t) = \begin{pmatrix} \phi_{1n}(t) \\ \phi_{2n}(t) \\ \vdots \\ \phi_{nn}(t) \end{pmatrix} \tag{8}$$

Is solutions of system (1)

Definition 2:

Then $n \times n$ determinant

$$\begin{vmatrix} \phi_{11} & \phi_{12} & \cdots & \phi_{1n} \\ \phi_{21} & \phi_{22} & \cdots & \phi_{2n} \\ \vdots & \vdots & & \vdots \\ \phi_{n1} & \phi_{n2} & \cdots & \phi_{nn} \end{vmatrix} \tag{9}$$

Is call the Wronskian of n vector functions $\phi_1, \phi_2, \dots, \phi_n$ defined by (8). We will denoted Wronskian by $W(\phi_1, \phi_2, \dots, \phi_n)$ and its value by $W(\phi_1, \phi_2, \dots, \phi_n)(t)$.

We get:

System of linear differential equation order-1 homogeneous

$$\frac{dy_i}{dx} + \sum_{j=1}^{n} a_{ij}(x) y_j = f_i(x), \quad i = 1, 2, \dots, n$$

have n solution $y_1, y_2, \dots, y_n$ where:

$$y_j(x) = \begin{bmatrix} y_{1j}(x) \\ y_{2j}(x) \\ \vdots \\ y_{nj}(x) \end{bmatrix}, \text{ j = 1, 2, ..., n}$$

Wronskian of solutions is:

$$W = \begin{vmatrix} y_{11}(t) & y_{12}(t) & \cdots & y_{1n}(t) \\ y_{21}(t) & y_{22}(t) & \cdots & y_{2n}(t) \\ \vdots & \vdots & & \vdots \\ y_{n1}(t) & y_{n2}(t) & \cdots & y_{nn}(t) \end{vmatrix}$$

The following section will discuss about linearly independent solutions (1) by Wronskian:

Theorem 2:

If the n vector function$\phi_1, \phi_2, \dots, \phi_n$defined by (8) are linearly dependent on$a \leq t \leq b$, then Wronskian$W(\phi_1, \phi_2, \dots, \phi_n)(t) = 0$ for all$t$ on$a \leq t \leq b$.

Proof:
Let $\phi_1, \phi_2, \dots, \phi_n$ are linearly independent on interval$a \leq t \leq b$
There exist n number $c_1, c_2, \dots, c_n$ not all zero, such that

$$c_1\phi_1(t) + c_2\phi_2(t) + \cdots + c_n\phi_n(t) = 0$$

for all $t\epsilon[a, b]$.
Using equation (13) of$\phi_1, \phi_2, \dots, \phi_n$
We have

$$\begin{gathered} c_1\phi_{11}(t) + c_2\phi_{12}(t) + \cdots + c_n\phi_{1n}(t) = 0 \\ c_1\phi_{21}(t) + c_2\phi_{22}(t) + \cdots + c_n\phi_{2n}(t) = 0 \\ \vdots \\ c_1\phi_{n1}(t) + c_2\phi_{n2}(t) + \cdots + c_n\phi_{nn}(t) = 0 \end{gathered}$$

for all $t\epsilon[a, b]$.
Let $t = t_0$, we have:

$$\begin{gathered} \phi_{11}(t_0)c_1 + \phi_{12}(t_0)c_2 + \cdots + \phi_{1n}(t_0)c_n = 0 \\ \phi_{21}(t_0)c_1 + \phi_{22}(t_0)c_2 + \cdots + \phi_{2n}(t_0)c_n = 0 \\ \vdots \\ \phi_{n1}(t_0)c_1 + \phi_{n2}(t_0)c_2 + \cdots + \phi_{nn}(t_0)c_n = 0 \end{gathered}$$

for$n$ number$c_1, c_2, \dots, c_n$.
Since$c_1, c_2, \dots, c_n$ are not all zero, we must have:

$$\begin{vmatrix} \phi_{11}(t_0) & \phi_{12}(t_0) & \cdots & \phi_{1n}(t_0) \\ \phi_{21}(t_0) & \phi_{22}(t_0) & \cdots & \phi_{2n}(t_0) \\ \vdots & \vdots & & \vdots \\ \phi_{n1}(t_0) & \phi_{n2}(t_0) & \cdots & \phi_{nn}(t_0) \end{vmatrix} = 0$$

But the left of Wronskian$W(\phi_1, \phi_2, \dots, \phi_n)(t_0)$, we have:

$$W(\phi_1, \phi_2, \dots, \phi_n)(t_0) = 0$$

Since t_0 is an arbitrary point of $[a, b]$, we must have:

$$W(\phi_1, \phi_2, \dots, \phi_n)(t) = 0$$

for all$a \leq t \leq b$■

Theorem 3:
Let the vector functions $\phi_1, \phi_2, \dots, \phi_n$defined by (8) be$n$ solutions of the homogeneous linear vector differential equation

$$\frac{d\mathbf{x}}{dt} = \mathbf{A}(t)\mathbf{x}$$

on the real interval $[a, b]$.
These$n$ solutions$\phi_1, \phi_2, \dots, \phi_n$ are linearly independent on$[a, b]$ if and only if

$$W(\phi_1, \phi_2, \dots, \phi_n)(t) \neq 0$$

for all $t \epsilon [a, b]$.

Proof:

Solutions$\phi_1, \phi_2, \ldots, \phi_n$ are linearly dependent on$[a, b]$ if and only if$W(\phi_1, \phi_2, \ldots, \phi_n)(t) = 0$ for all $t \epsilon [a, b]$.
Hence, $\phi_1, \phi_2, \ldots, \phi_n$ are linearly independent on $[a, b]$ if and only if$W(\phi_1, \phi_2, \ldots, \phi_n)(t_0) \neq 0$ for some $t_0 \epsilon [a, b]$.
Then, $W(\phi_1, \phi_2, \ldots, \phi_n)(t_0) \neq 0$ for some $t_0 \epsilon [a, b]$ if and only if $W(\phi_1, \phi_2, \ldots, \phi_n)(t) \neq 0$ for all $t \epsilon [a, b]$■

CONCLUSION

1. System of linear diferential equation order-1 is form

$$\frac{dy_i}{dx} + \sum_{j=1}^{n} a_{ij}(x) y_j = f_i(x), \quad i = 1, 2, \ldots, n$$

   has n solution $y_1, y_2, \ldots, y_n$ where:

$$y_j(x) = \begin{bmatrix} y_{1j}(x) \\ y_{2j}(x) \\ \vdots \\ y_{nj}(x) \end{bmatrix}, \text{ j = 1, 2, ..., n}$$

2. Wronskian of solutions of system of linear differential equation order-1 is:

$$W = \begin{vmatrix} y_{11}(t) & y_{12}(t) & \cdots & y_{1n}(t) \\ y_{21}(t) & y_{22}(t) & \cdots & y_{2n}(t) \\ \vdots & \vdots & & \vdots \\ y_{n1}(t) & y_{n2}(t) & \cdots & y_{nn}(t) \end{vmatrix}$$

3. Solutions of system of linear differential equation are linearly independent if the Wronskian is not equal to zero.

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IMPROVING MATHEMATICAL CONNECTION ABILITY STUDENTS USING CONSTRUCTIVISM APPROACH

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Abstract

This paper aims to determine the differences in the ability of connections between students who acquired learning mathematics with constructivism approach and conventional learning. The ability of connections is an important competency that must be possessed by students in order to create a meaningful mathematics learning environment. The connection capability aims to enable students to: (1) Recognize the equivalent representation of a similar concept, (2) Recognize the relation of a representative procedure to equivalent representational procedures, (3) Use and assess the connection of several mathematical topics, (4) Use and Assessing the connection between mathematics and other disciplines. The facts about the low competence of students to mathematics in Indonesia based on various surveys have been able to show the fact that math is still less interested students. In this case the need for learning that can improve the ability of this mathematical connection. One solution to overcome this is to provide effective efforts such as the provision of appropriate methods, approaches or techniques. One is the constructivism approach. With the constructivism learning model, the students are directed to build their own knowledge, here the students are active and make the learning process situation more interesting, while for the teacher can help and lead in giving the lesson material in the form of concept, principle or theory so that the younger is understood by the students, Constructivism gives students more experience. Based on the study of constructivism approach and the ability of mathematical connections to have a relationship that is the same learning process that will produce the same ability indicators, so that constructivism approach is expected to develop the ability of mathematical connection.

Keywords: *Constructivism Approach, Mathematical Connection Ability*

PRELIMINARY

Depdiknas (2006: 345) states that mathematics lessons should be given to all students starting from elementary school to equip students with logical, analytical, systematic, critical and creative thinking skills, as well as the ability to cooperate. Such competencies are required for students to have the ability to acquire, manage, and utilize information for survival in an ever-changing, uncertain and competitive state.

This is in line with what Sabandar (2008), where in the mathematics lesson in schools is not only aimed at getting students to understand the mathematical material being taught, but the other major goals are student must have mathematical reasoning, mathematical communication, mathematical connections, representation of mathematics and problem-solving, certain that a student should earn after learning math.

According to the National Council of Teachers of Mathematics (NCTM) 2000 in America, there are five basic mathematical skills that are standard: problem solving, reasoning and proof, communication, connections, And representation. With reference to the five standards of NCTM capability above, the mathematics learning objectives set out in the kurikulum 2006 issued by Depdikans essentially include: (1) the connection between concepts in mathematics and their use in solving problems, (2) reasoning, (3) problem solving , (4) communication and representation, and (5) affective factors.

Based on the above quotations it can be said that important connection ability possessed by students. NCTM in Herdian (2010) states the goal of mathematical connections given to students in secondary schools is that students can: (1) Recognize equivalent representations of a similar concept, (2) Recognize the relationship of one representation procedure to equivalent representational procedures, (3)) Using and assessing the connection of several mathematical topics, (4) Using and assessing connections between mathematics and other disciplines. According to NCTM (Setiawan, 2009: 15), mathematical connections are divided into three classifications, there are (1) connections between math topics, 2) connections with other sciences, and (3) connections with problems in daily.

The important connections ability is owned by students so that they are able to connect between the material one with the other material. Students can understand the mathematical concepts they learn because they have mastered the prerequisite materials related to everyday life. In addition, if students are able to associate the material they have learned with previous subjects or with other subjects, then math learning becomes more meaningful. According to Kusuma (2008: 2), students' mathematical connection ability can be seen from the following indicators: (1) recognizing the equivalent representation of the same concept; (2) recognizing the relation of mathematical procedure to an equivalent representation of representation procedures; (3) using and assessing the interrelationships between mathematical topics and interconnectedness outside mathematics; and (4) using mathematics daily.

Trend in International Mathematics and Science Study (TIMSS), a study organized by the International Association for the EEI of Educational Achievement (IEA), in 2007 placed Indonesian VIII students in rank 36 out of 49 countries that participated with a score of 397 , While the mean international score is 500 (Mullis, et al., 2008). The scores obtained are significantly below the average international score.

The conclusions of the TIMSS study report are not much different from the results of the 2009 PISA survey. Students' mathematics learning achievement in Indonesia from PISA is ranked 61 out of 65 countries that participated with the average score of 371, while the mean international score was 500 (Balitbang, 2011).

The fact in the field of mathematics learning still tends to focus on textbooks, still often found the math teacher still teaching by using learning steps such as: presenting learning materials, provide examples of questions and ask students to do the exercise questions contained in the book The text they use in teaching and then discuss it with the students. This is according to the findings of Wahyudin (1999) that most students seem to follow well any explanation or information from the teacher, the students very rarely ask questions to the teacher so that the teacher is absorbed in explaining what Has been prepared, meaning that students only accept only what is delivered by the teacher. Teachers generally teach by lecture and expository methods (Wahyudin, 1999). This is supported by Ruseffendi (2006) which states that during this time in the process of learning mathematics class, in general students learn mathematics is only told by the teacher and not through exploration activities. It all indicates that students are not active in learning. Through this process of learning, it is unlikely that mathematical ability can develop.

From the exposure of this fact, the need for learning that conditioned the students actively in learning mathematics. Henningsen and Stein (1997) suggest that in order to develop students' mathematical abilities, learning must be an environment where students are able to be actively involved in many useful mathematical activities. Students must be active in learning, not just copying or following examples without knowing the meaning. One of student-centered learning is the constructivism approach.

According to Hudojo (1998:6) the study of mathematics in the view of constructivism is to help students build mathematical concepts and principles with their own ability through the process of internalization and transformation of the concepts and principles that re-awakened into new concepts/principles. Therefore, learning mathematics is an active process in an effort to help students build understanding. Good & Brophy (in Kauchack & Eggen, 1998: 185) mentions the characteristics of constructivism learning in general as follows. 1). Students build their own understanding 2). New learning depends on previous understanding 3). Learning facilitated by social interaction 4). Learning meaningful occur in self-study tasks. According Sanjaya (2009: 264) constructivism is the process of building or composing new knowledge in the cognitive structure of students based on experience. With the constructivism learning model, the students are directed to build their own knowledge, here the students are active and make the learning process situation more interesting, while for the teacher can help and lead in giving the lesson material in the form of concept, principle or theory so that the younger is understood by the students, Constructivism gives students more experience.

According to Nurhadi (2003: 39) there are several learning steps with constructivism approach that is as follows: "1) Activation of existing knowledge; 2) acquisition of new knowledge; 3) Understanding of knowledge; 4) Applying the knowledge and experience gained; 5) Reflecting".

Table 1: Steps of Constructivism approach in the learning process

Stage	Teacher's Behavior
Stage 1 Convey goals and motivate students	The teacher conveys the learning objectives to be achieved on the lesson activities and emphasizes the importance of the topics to be learned and motivates the student to learn
Stage 2 Apperception	Teachers convey information or previous material so that students are able to connect prior learning to the material to be discussed
Stage 3 Submission of Lessons	The teacher delivers the material and explains the material to be learned then the teacher gives each student the material that must be completed

Stage 4 Implementation of learning	The teacher acts as a facilitator in learning, with the subject of students who play an active role in the process of problem solving through ideas and thoughts and knowledge that students have
Stage 5 Evaluation	Teachers evaluate learning outcomes on materials that have been assigned to each student

Source: Trianto (2009: 29)

Based on the study of constructivism approach and the ability of mathematical connections have the same learning process that will produce the same ability indicators. Phase 1, that conveys the purpose and motivates the students, with the delivery of this goal and motivation students know the benefits and importance of learning to be learned. At this stage students are trained to recognize the appropriate concept so as to present it, this corresponds to the first indicator of mathematical connection ability. Stage 2 is apperception, the stage of attributing the material with previous learning as the initial concept. At this stage students are trained to recognize the relationship of mathematical procedures, this corresponds to the second indicator of mathematical connection capability. Phase 3 is the delivery of subject matter, the stage of delivery of concepts and stabilization, so that students can know fully about the topic and provide problems related to other fields of science. At this stage students are trained to use mathematical topics that correspond to the third indicator of mathematical connection capability. Stage 4 is the implementation of learning, the stage where the teacher only becomes a facilitator during the students using the knowledge gained from the previous stage. At this stage students are trained to use mathematics in life that corresponds to the fourth indicator of mathematical connection ability. In this case, it is seen that every step of the constructivism approach meets every indicator of mathematical connection ability.

CONCLUSION

From description above, it is known that constructivism approach has relevance to indicator ability of mathematical connection. Stage 1 of constructivism approach will be related to the first indicator of mathematical connection ability, stage 2 of constructivism approach will be related to the second indicator of mathematical connection ability, stage 3 constructivism approach will be related to third indicator of mathematical connection ability, stage 4 constructivism approach will be related to fourth indicator of connection capability mathematical. Therefore, constructivism approach can improve students' mathematical connection ability.

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IMPROVEMENT THE ABILITY TO COMMUNICATION OF MATHEMATICS TO THE STUDENTS BY USING COOPERATIVE LEARNING MODEL TYPE NUMBERED HEADS TOGETHER (NHT)

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Abstract

This study aims to discuss the appropriate alternative theory used to improve the ability of mathematical communication of students who are still low. One of the factors that resulted in low mathematical communication of learners is the theory of learning that teachers use less train students desire in improving students' mathematical communication. The alternative theory used to improve mathematical communication ability of learners in this writing is the model of learning Numbered Heads Together (NHT). This type encourages students to improve the spirit of cooperation and mutual relationships with colleagues so that the group is expected to facilitate students in improving the ability of mathematical communication. This learning model also requires students to engage in various activities that are done continuously, and the teacher provides many opportunities for students to interact to convey ideas, reflect on ideas given friends and discuss the idea of equating with friends, so more active in conducting discussions Groups and also train students to skillfully demonstrate their existence when answering questions and developing aspects of mathematical communication. The method used in this study is a study of literature study by collecting data about the NHT model of mathematical ability from various sources such as relevant research, books, etc. After conducting literature studies by citing data from various sources it is suspected that NHT model theory can improve the mathematical ability of learners at the junior high school level (SMP).

Keywords *- mathematic communication skills,NHT model*

PRELIMINARY

Mathematics is a very important science as the form of attitude and mindset. Mathematics is taught in all levels of education, from basic education to college level. Learning programs at all levels of education should be able to make students consolidate their mathematical thoughts through logical and clear communication to others, able to analyze other people's mathematical thoughts, and be able to use mathematical language in expressing mathematical ideas.

Given the importance of the role of mathematics, various efforts have been made by the government to improve the quality of mathematics education, such as improving the curriculum, procurement and development of educational facilities and infrastructure, and improving the quality of teaching staff.

The purpose of mathematics learning as stated in Permendikbud No. 58 year 2014 is that learners: understand the concept, using patterns, using reasoning, communicate ideas, have an attitude of appreciation, have attitudes and behaviors that are in accordance with the values in mathematics and learning, - motor activities, using simple props [1]. Based on the objectives of mathematics learning above, it appears that mathematical communication is one of the competencies that plays an important role in the delivery of mathematical ideas either in writing or orally with symbols, tables, and diagrams or other media to clarify a situation or problem. In learning mathematics required the ability of good communication to communicate the message of mathematical communication problems delivered can be understood by others and mathematical problems can be answered clearly.

Students who have the ability to communicate ideas or mathematical ideas well tends to have a good understanding of the concepts learned and able to solve problems related to the concepts studied. This resulted in students the opportunity to communicate their ideas, both orally and in writing, which is one of the important goals in learning mathematics. In a study conducted by Dini Widyastuty 2014, the reality of the field has not been as expected, the ability to communicate mathematics is not optimal [2]. This can be seen when students are given the problem of daily repetition time by the teacher seems lack of mathematical communication of students in answering the given problem. Students are also often wrong in interpreting the intent of the problem so it has not been able to present solutions of mathematical problems in detail and correctly. This indicates a lack of students 'ability to illustrate mathematical ideas into relevant forms of description resulting in a lack of students' ability to change the shape of the description into the mathematical model.

To solve the above problem, in learning mathematics students need to be accustomed to provide arguments for each answer and respond to answers given by others, so that what is being learned becomes more meaningful for him. This means that in learning, it gives time for students to discuss in answering, responding to questions, and other people's questions with true and obvious arguments is very important.

Based on the above explanation, then the teacher is important to choose the right learning model in order to improve students' mathematical communication ability in learning. Therefore, it is necessary that there is a learning that emphasizes the active student learning where in the learning there is active participation of students so that there will be active multi-directional communication with both teachers and students and among students themselves. Cooperative learning is one of the learning models that can increase students' activeness and involvement. An effective learning that can be applied to improve the communication skills of mathematics is one of them is cooperative learning type Numbered Heads Together (NHT).

NHT type learning has four major phases: numbering, asking questions, thinking together, and answering. Numbering is the students divided into multiple groups heterogeneously and each student in each group gets the serial number. Asking questions is the teacher asks the student questions. Together Thinking is on this occasion each student brings together his head "Heads Together" from his information and compiles their own knowledge by discussing to communicate his ideas so that students are able to unite the final answer of the teacher's problem. Answering is a teacher calling a number and students from each group with the same number raising hands and communicating the answer in front of the class [3]

This type encourages students to improve the spirit of cooperation and mutual relationships with colleagues so that the group is expected to facilitate students in improving the ability of mathematical communication. This learning model also requires students to engage in various activities that are done continuously, and the teacher provides many opportunities for students to interact to convey ideas, reflect on the ideas given friends and discuss the idea of equating with friends, so more active in conducting discussions groups and also train students to skillfully demonstrate their existence when answering questions and developing aspects of mathematical communication. Thus the course of the learning process will be able to achieve the expected goals with the visible increase in student achievement.

In the application of cooperative learning model type NHT can help students in improving the ability of mathematical communication. This is seen in the learning stages. In the numbering stage, by getting the serial number of each member of the group will cause a sense of responsibility in the student self because if the serial number is called then the student will go forward represent the group. With the numbering of each group and group members will encourage students to improve the spirit of cooperation and mutual relationships with colleagues so that the group is expected to facilitate students in improving the ability of mathematical communication. In the Asking Question stage, because of the high spirit of learning it will arise questions from students to teachers and vice versa so that it can help students train communication skills in answering questions either in writing or oral. The next stage of Mutual Thinking can help students integrate the information they possess and organize their knowledge by discussing to communicate their ideas so that students are able to integrate the final answers to the problems given. Stage Answering, training students to express communication skills in front of the classroom and from that answer the teacher can develop student communication with deeper discussion between groups, so that will find the final answer of the question as a complete answer. At times like this it will appear that each student has a different experience and presents it in different ways.

The ability of students in communicating mathematics to the application of this model is seen based on the final test results given. The indicator of mathematical communication ability tested through the test question consists of three indicators, namely: (1) presents mathematical statements in writing and drawings; (2) performing mathematical manipulation; And (3) draw conclusions, construct evidence, or give reasons for some solutions [4].

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. These data sources contain: mathematical communication skills and NHT learning models. The sources are derived from relevant research, books, articles and internet sites.

RESULTS AND DISCUSSION

Based on the results of the literature study, the Numbered Heads Together (NHT) cooperative learning model is a form of learning developed by Spencer Kangen (1993) [3] to engage more students in examining the material covered in a lesson and checking their understanding of Content of the lesson. This learning provides an opportunity for students to share ideas and consider the right answers. In addition, this learning also encourages students to improve their cooperation spirit. Numbered Heads

Together (NHT) has explicitly defined procedures to give students more time to think, discuss, help each other in answering questions.

Learning using NHT method begins with Numbering. Teacher divides the class into small groups. The number of groups should consider the number of concepts studied. If the number of learners in a class consists of 30 people and is divided into 5 groups based on the number of concepts studied, then each group consists of 6 people. Each person in the group is numbered 1-6.

Once the group is formed the teacher asks several questions that must be answered by each group. Give each group a chance to put their heads together "Head Together" to discuss the answers to the teacher's questions.

The next step is the teacher calls the learner who has the same number from each group. They are given the opportunity to answer the questions they have received from the teacher. This continues until all learners of the same number from each group get a turn to explain the answers to the teacher's questions. Based on these answers teachers can develop more in-depth discussion, so that learners can find the answer to the question as a complete knowledge.

The structure used by teachers in asking questions in the classroom are four phases as the syntax of NHT expressed by Muslims (2001: 28) [3] as follows:

a. Step 1: numbering
   In this phase, the teacher divides the students into groups of 3-6 people and to each member of the group given the numbers 1 through 6.
b. Step 2: ask questions
   The teacher asks a question to the students. Questions may vary. Questions can be very specific and in the form of a question sentence.
c. Step 3: think together
   Students unite their opinions on the answers to these questions and convince each member of his team to know the team's answers.
d. Step 4: answer
   The teacher calls a certain number, then the appropriate student raises his hand and tries to answer the question for the whole class.

Communication is a way to express ideas with words, symbols, and diagrams. Through communication then one can clarify their thinking by issuing or writing words, symbols, or diagrams while thinking about what they are doing. In connection with this, in learning mathematics required a good communication skills so that math problems can be answered clearly.

Mathematical communication is an important skill in mathematics, according to The Intended Learning Outcomes (in Armiati, 2009: 2), Mathematical communication is to express math ideas coherently to friends, teachers, and others through spoken and written language [5]. This means that with the communication of mathematics teachers can better understand the ability of students in interpreting and expressing their understanding of the concepts they learn. Communication in mathematics education can be developed by giving students opportunities to hear, talk, write, read, and present mathematical ideas.

In line with Greenes and Schulman's opinion (in Armiati, 2009: 3), the importance of communication because of several things is to express ideas through conversation, writing, demonstration, and visual painting in different types;

Understand, interpret, and evaluate ideas presented in writing or in visual form; Construct, interpret, and relate various forms of representation of ideas and relationships; Make observations and conjectures, formulate questions, carry and evaluate information; Produce and state arguments persuasive [5].

From the above explanation and the study of literature in learning mathematics students should be able to communicate their ideas and understanding. With this mathematical communication the teacher can measure the extent to which students' understanding of a material. The ability of students' mathematical communication is one of the determinants of whether students already understand the mathematical concepts that have been learned during the learning process. This math communication not only states ideas but students can also explain, describe, hear, ask, clarify, work the same and finally be able to report what it has gained. This is what will be developed by applying NHT learning strategies.

CONCLUSIONS AND RECOMMENDATIONS

Based on the literature study and discussion above, it can be concluded that the mathematical communication ability of students learning by using cooperative learning model of Numbered Heads Together (NHT) is better than the students' mathematical communication ability that learn with conventional learning. This type encourages students to improve the spirit of cooperation and mutual relationships with colleagues so that the group is expected to facilitate students in improving the ability of mathematical communication. This learning model also requires students to engage in various activities that are done continuously, and the teacher provides many opportunities for students to interact to convey ideas, reflect on ideas given friends and discuss the idea of equating with friends, so more active in conducting discussions Groups and also train students to skillfully demonstrate their existence when answering questions and developing aspects of mathematical communication. Thus the course of the learning process will be able to achieve the expected goals with the visible increase in student achievement.

Based on the results of research, it is advisable:

1) NHT type cooperative learning model can be used as an alternative learning by teachers in learning mathematics in school to improve students' mathematical communication skills.
2) For other interested researchers, it is expected to design time allocations for each of the steps on cooperative learning model of NHT type better and form the right group members so that the learning process can run smoothly.
3) This research is still limited to students' mathematical communication ability. Therefore, it is expected to further researchers to continue the research with the ability and other subjects.

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THE APPROACH OF METACOGNITION IN THE INCREASE OF HIGHER ORDER THINKING SKILLS (HOTS) IN LEARNING MATHEMATICS

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Abstract

Metacognition is a person's skills in organizing and controlling his thinking process, that is why Metacognition can be said as a person's thinking about the way he thinks about himself. Thinking is bestowing the intellect's activity for a particular purpose. Thinking is the identity that separate the humanitarian status of the human being with another. Therefore how far the human called human can be distinguished from how far he using his mind. thingking is distinguished in two levels of thinking. They are think to figure out is the low level of thinking (lower) while the rate is the high level of thought (higher). Metacognition has the features of public-domain and domain-specific. Therefore, it makes sense to learn about Metacognition in the context of the public and also in the context of the specific school discipline and even in the context of more specific learning objectives. The purpose of this study is to present a general overview of how the role of Metacognition in teaching Higher Order Thinking Skills (HOTS) in learning mathematics. This research is the study of literature, with the spool data or resources related to the approach of Metacognition and Higher Order Thinking Skills (HOTS). Based on the results of the research that has been done then it can be inferred that the higher order thinking skills and Metacognition as the process of organizing knowledge, and higher-order thinking serves as the refinement of knowledge. For students to have the skills of a high level of Metacognition of thinking needs to be applied in achieving the success of the process of thinking.

Keyword: *Metacognition, Higher Order Thinking Skills (HOTS)*

INTRODUCTION

2013 curriculum emphasize students to perform observation, do questioning, reasoning, and communicate what they have acquired after receiving lessons. In addition, 2013 curriculum see that knowledge cannot be transferred directly from the teacher to the students (Nuh: 2013). In order to make students truely understand and can apply what has been known, students must be trained to solve a problem, find everything for themselves, and strive embody his ideas. In this case, a high level thinking skills students are instrumental to achieve the educational goals of success.

High level thinking skills improvement has become one of the priorities in learning mathematics. As expected on the core competency of knowledge Curriculum 2013 explained that the learners are expected to understand, implement, and analyze factual knowledge, conceptual, procedural, and Metacognition based on curiosity about science. So on core competency Skills learners are expected to cultivate,give reason, and present in the real of concrete and abstract domains associated with the development of which he had learned in school independently, act effectively and creatively, as well as being able to use the method according to academic rules

The evaluation or assessment of learning activities is aimed at building a scientific attitude and thinking ability. From the data obtained, processed, classification is made and found specific relationships. Activities can be designed by the teacher, through a situation engineered in certain activities so that learners undertake activities such as: analyzing data, classify, create categories, concludes, and predict or of the discussion or practice. The results of the activities tried and associate allows the *higher order thinking skills (HOTS*) to think metacognition.

Mathematic's learning is expected for learners can develop themselves in thinking. The students are required not only has lower order thinking skills, but to the *higher order thinking skills (HOTS)*. So that learners should be familiar to face problems that require higher order thinking skills. Because *the HOTS* is the ability to think, connect, to examine and evaluate all aspects of the situation and problems. This includes collecting, organizing, remembering, and analyze information. Higher-order thinking includes the ability to read with understanding and identifying material is needed and not needed. The ability of the correct inferences from the data provided and was able to determine an inconsistent state and its conflict in a group of data is part of high-level thinking skills.

Training students to have the ability to *higher order thinking skills (HOTS)*, student need to be trained by approach that has access to the *higher order thinking skills (HOTS)*, one of them are Metacognition. Metacognition is a term introduced by Flavell in 1976 and havemuch debate at definition. Metacognition is an adjective of Metacognition, Metacognition is derived from the word *"metacognition"* with prefix "meta" and "cognition '. Derived from the Greek meta meaning "after", "beyond" or "on top". Metacognition is essentially an activity the activities of "thinking about thinking", which is an activity control consciously about the process of kognitifnya of its own. Activities activities include Metacognition of thinking to plan, monitor, merefleksi how to solve a problem.

According to McDevitt and Ormrod *"the term metacognition refers both to the knowledge that people have about their own cognitive processes and to the intentional use of certain cognitive processes to improve learning and memory."*. That is, knowledge of someone about his thinking process and deliberately used to enhance learning and memory. According to metakognition theory that students who learn certain skills to organize and control what he had learned. This skill differs between individuals with other individuals in accordance with the capabilities of his thinking process. The four types of skills: problem solving, decision making, critical thinking, and creative thinking.

Since the beginning of the study, the training and instruction of Metacognition Metacognition has been proved give a positive effect on the performance of children in various fields. As we will see below, Metacognition has a feature of public-domain and domain-specific. Therefore, it makes sense to learn about Metacognition in the context of the public and also in the context of the specific school discipline and even in the context of more specific learning objectives. Thus, this research is presenting an overview on the role of Metacognition in increasing the ability of *Higher Order Thinking Skills(HOTS*) in learning mathematics.

RESEARCH METHODS

This research is a research study of the literature. Study of literature is the way used for collect data or resources related to the topics raised in a research. On the research, it will be learn how the role of Metacognition in teaching *Higher Order Thinking Skills*(*HOTS*).

RESULTS AND DISCUSSION

Metacognition as a form of cognition, or thinking processes two or more levels that involve control of cognitive activity. That is why Metacognition can be said to be as much about a person's own thinking. When someone knows what are the factors that affect the process of his own cognitive, figure out which tasks are considered heavy or easily and knowing what is known, means a person that has mastered the her metacognition. Metacognition is a form of the ability to see yourself so, what is done can be optimally controlled. A person with ability as it is possible to have high abilities in solving problems. This is because in every step he always emerges the question what do I do?, why am I working on?, what can help me in solving this problem.

Metacognition refers to a person's understanding about his knowledge, so a deep understanding about effective knowledge or a clear description of the knowledge in question. This, suggests that knowledge cognition is consciousness a person about what he knows and the regulation of cognition is how one governs the activity of kognitifnya effectively.

Defenition of Metacognition expressed by experts at the top of the very diverse, but in fact give emphasis on knowledge and awareness about his thinking process on its own. Metacognition has a very important meaning, because knowledge about cognition process itself can guide in setting the mood and choose a strategy to improve the cognitive ability of our future comes. While Metacognition on study is the knowledge, awareness and control of the process and the results of one's thinking.

In Theresia Kriswianti N (2008:121) according to Flavel a person's ability to monitor a variety of activities conducted through kognisinya action and interaction between 4 components namely (1) Knowledge Metacognition (metacognitive knowledge) (2) the experience of Metacognition (metacognitive experience) (3) goals or tasks (goals ortasks) (4) the actions or strategies (actions or strategies).

Knowledge of Metacognition is knowledge a person about the thought process that is a personal perspective from the ability of others. Experience is the experience of cognition or Metacognition affective accompaniments and cognitive activities relate to all. In other words, the experience of Metacognition is a conscious consideration of intellectual experiences that accompany a failure or success in the lessons. The goal or task refers to objective thinking as read and understand a passage to the next quiz, which will trigger the use of the knowledge and experience to encourage Metacognition metacognition. Actions or strategies pointed to specific behavior or thinking that are used to implement them, which can help to achieve the goal.

The role of Metacognition in teaching higher-order thinking (HOT) in the learning of mathematics. In this case the term HOTS to describe cognitive activity is beyond the stage of withdrawal and understanding. According to Bloom's taxonomy (1956) and according to the latest revision of the model (for example, Krathwohl, 2002; Leighton, 2011). Apply, analyze, evaluate, and create is the main educational objectives at the level of HOT. Examples of cognitive activity are classified as HOT include building arguments, asking questions of research, make a comparison, the face of controversy, and build causal relationships (Zohar, 2004). Cognitive activity is used to carry out such a process of scientific inquiry, problem solving, decision-making, critical thinking and argumentation,

According to Heong's, dkk (2011) high level thinking ability was the use of the mind to find new challenges. High level thinking ability demanding someone to apply new information or knowledge which had belonged to him and manipulating information to reach out to possible answers to new situations. According to Brookhart in an instant sense of higher-order thinking is as follows:

> *Higher- order thnking conceived of as the top end of the Bloom's cognitive taxonomy. The teaching goal behind any of the cognitive taxonomies is equipping students to be able to do the transfer. "Being able to think" means students can apply the knowledge and skills they developed during their learning to new contexts. The "New" here means applications that the student has not thought of before, not necessarily universally something new. Higherorder thinking is conceived u.s. students being able to relate their learning to other elements beyond those they were taught to associate with it.*

Above definition explains that the purpose of teaching based on Bloom's taxonomy of the cognitive is to require students to apply the knowledge and skills to new contexts, i.e. students can apply the concepts that have not been thought of before. In the revised Bloom's taxonomy of thinking ability involves high level analysis (C4), evaluating (C5) and created (C6) is considered higher-order thinking (Andreson & Krathworl, 2001). Anderson did the research and created the improvement against the taxonomy of Bloom. The improvement has changed the Bloom taxonomy from a noun (a*noun*) into a verb (*verb*). This is important to be done due to Bloom taxonomy actually is description of thinking process. Besides that, there is also a the shift from lower-level thought processes (*low order thinking*) to high level thinking processes (*higher order thinking*).

Table: Taxonomic Distinction Bloom and Anderson

Bloom's Taxonomy	**A Revision Of Bloom's Taxonomy**
Knowledge	Memorizing
Understanding	Understanding
The application of the	Applying
Anilisis	Analyzing
Synthesis	Judging
Assessment	Creating

(Andrerson & Krathworl, 2001)

In the taksonomoi Bloom cognitive domain is known only one dimension but in Anderson and Krathwohl's taxonomy into two dimensions. The first dimension is the *Knowledge Dimension* (the dimension of knowledge) and *CognitiveProcess Dimension* (the dimension of the process of cognition). Cognition process dimensions there are 6 categories, namely the ability of remembering, understanding, applying and which is the lower-level thinking ability. In addition the ability to analyze, evaluate, and create including high level thinking ability.

Skills such as critical and creative thinking, problem solving, analysis and visualization capabilities included in higher-order thinking or *Higher OrderThinking Skills* (*HOTS*). This skill involves categorizing the grain problem, compare and distinguish ideas and theories, capable of writing as well as solving the problem. In this study, high levels of Mathematics thinking ability that is developed is the ability to analyze (*analyze*), evaluating (*evaluate*) and create (*create)* in the field of physics. Anderson & Krathwohl (2001:30) defines the capabilities of the third as follows:

> *Analyzing the material is breaking the concepts into parts, determining how the parts relate or interrelate to one another or to an overall structure orpurpose. Evaluating is making judgments based on criteria and standardsthorough checking and critiguing. Creating is putting element together toform a coherent or functional whole; reorganizing elements into a newpattern or structure thorough generating, producing and plabning.*

This definition States that: (1) analyze is outlining the material or concepts into parts, determining relationships between parts, or parts to the structure or relationship goals overall. The appropriate action in the form of differentiating, organizing, and linking, as well as being able to distinguish between components or parts; (2) Evaluating is to make an assessment based on the criteria and standards with a through examination and criticism; (3) Create is the inclusion of the elements to form a single coherent unity or functional or reorganize elements into patterns or new structures through the process evokes, plan, or produce. Activities include creating is synthesizing the section into something new, new products.

Thus, the ability to *Higher Order Thinking Skills(HOTS)* is a thinking skills that not only requires the capability of remembering, but also other higher capabilities include the ability to analyze, evaluate, and create.

In higher-order thinking skills include learning activities in deciding against things that are complex areas such as critical thinking and thinking in solving problems. Despite the high level of thinking is indeed difficult to be learned and taught, but its usefulness is already no doubt. Think on a higher level than just memorize facts or say something to someone exactly like something that was told to us. At the moment a person memorize and deliver returns that information without having to think about it, called rote memory (*rote memory*). The person is not different from the robots, in fact he did whatever he did, so he programmed also cannot think for himself. Higher-order thinking in a nutshell can be described as the attainment of a high level of thinking to thinking from the mere repetition of the facts. Higher-order thinking requires that we do things over the facts. We must memahamnya, connecting to each other, manipulate, categorize, put them together with new ways, and to apply them in the search for new solutions to new problems. For some people think high level can be done easily, but for oranglain would not necessarily be done. However it does not mean higher-order thinking can not be studied, as well as skills in General, higher-order thinking can be learned by everyone.

Current theories which grew about *Higher-order Thinking Skills* more focussed on how these skills are learned and developed. Appropriate teaching strategies and learning environment which can facilitate students ' thinking ability is an important factor for the achievement of this approach. As with any student persistence, monitoring, and an open and flexible attitude of thinking.

In high level thinking, needed the ability reasoning. Where critical thinking and reasoning ability of these interconnected. This is in line with the opinion Krulik and Rudnick (1995:2), that covers the basic thinking critical thinking, and creative thinking It is this last thought two levels (critical thinking and creative thinking) is called a high level thinking skills that should be developed in learning mathematics and will be discussed in this paper.

Some of the main concepts in accordance with the approach of the HOTS is following the third assumption about thinking and learning:

a. Think could not be linked from the level, they are interdependent of each other
b. The Thinking or not thinking can be learned without the content, only the theoretical points. In real life, students will learn the subject matter based on the experiences of his school. For example to be able to master the concept of calculus 2, they should have mastered calculus 1 first. Experience on previous schools will help them learn the higher the next year
c. HOTS include various ways of thinking, processing, as well as apply on combined and variable situations multiples thereafter.

Therefore , *Higher Order Thinking Skills (HOTS)* is believed to better prepare students to meet the challenges. *Higher Order Thinking Skills (HOTS)* placed the student to manipulate information and ideas with car change the meaning and its implications. The transformation occurs when students connect the facts and ideas in order to mensisntesis, generalize, describe, hypothesize or even to draw conclusions or interference of manipulating ideas. Through this process allows students to solve problems and to find meaning and understand it.

Some of the questions that a teacher can use to cultivate students ' critical thinks pattern among others: is there any other way? (*What's another way?*), what if ...? (*What if ...?*), what is wrong? (*What's wrong?*), and what will be done? (*What would you do?*) (Krulik & Rudnick, 1999).

Examples of innovative question "*is there any other way?*"

1. *a company of furniture will create two types of three-legged stools and four-legged. Both types of bench uses the same type of feet. On one occasion this company gets an order for 340 feet for a 100 benches. How much does each type of stool that would be produced?*

With memisalkan: x = a lot of three-legged stool
y = a lot of four-legged stool

$$x + y = 100$$
$$3x + 4y = 340$$

So in many ways will be retrieved a three-legged stool 60 and 40-four-legged stool. Next the teacher may question the likelihood of another way to get the same answer. Since there is no change in the problem, this question will motivate students to find another way or another answer. Therefore, this activity became a good way to practice critical thinking.

Unlike the example of the first event, the following activities were conducted after the condition on the matter of amended. This change makes students re-examine the problem and see if this changes against the influence of the process of settlement and also the answer. By this way the student will analyze what happened so that it will enhance their critical thinking. Here's an example:

5 17 3 11 10 25 9 15 31

Yani took four number cards are worth 31, 5, 9 and 10. What is the total value of the cards the numbers?

With a simple summation process retrieved answer 55. Now ask the question: ***What if****...*

a) *What if Yani took four cards with a total value of 55? Where is the number of cards taken*

Many answers to this question. That is, there are many correct answers. This last question requires more analysis, not merely exercise the summation.

What if ...? 2

b) *What if the card numbers 10 discarded? If Yani took four cards with a total value of 55, which cards taken*

This problem makes students analyze further. After trying several combinations students will realize that the numbers are impossible to obtain. Why? What is its mathematical explanation? The sum of two even numbers is always going to be fulfilled, so there may be obtained 55.

By asking what if ...? The issue of routine can be transformed into an activity of interest to the member the opportunity to use critical thinking. But, while solving in mathematics, students need to know what is the problem to be solved, for knowledge Metacognition about when, why, and how do strategy, or, to use the terminology that is served before, this was knowledge of metacognition. To truly control problems during the process of problem solving students also need to plan their actions carefully, to monitor their actions to see if everything goes according to plan, and to evaluate whether they actually understand the issue correctly and if their conclusions are valid. This evaluation can direct students to conclude that they need to devise a new strategy and better. That is to say, the success of the strategy of the HOTS also requires skills such as planning, monitoring, evaluation, and settings. In the next part we will look deeper into why knowledge Metacognition and Metacognition skills is essential for a competent and efficient HOTS.

Contribution of knowledge and skills in Metacognition in learning the HOTS towards thinking is based on the observation that children at any given time have different thinking strategies that they use with different relative frequencies (Kuhn, 2000a; Kuhn, Garcia-Mila, Zohar, & Andersen, 1995; Siegler, 1996). Therefore, development is seen as an increased ability to choose effective strategies from a large number of strategies with varying levels of effectiveness. According to Kuhn (1999, 2000b), at this point that knowledge becomes important, because it is an important factor in the increased ability to choose strategies that are more accurate.

The claim that by increasing the knowledge of the student's Metacognition can improve strategic thinking implies that the beneficial to try and teach that knowledge rather than wait until it evolves itself. Help accessing knowledge Metacognition in class often helps students see the structure of the public thinking that are embedded in the difficulties they face. For example, students might not see the relationship between the activity of the investigation that they did in class in terms of the experiment the dice before they discuss topics regarding the chances of an event. The teacher, however, can explicitly indicate that these two activities have featured the same investigation cycle and that the rules they learned about the need to control problems that apply in both cases. By using explicit general knowledge related to knowledge Metacognition in the teaching of thinking, that's a kind of "bridging" activity that can increase the transfer (Adey and Shayer, 1993).

Metacognition skills contribution against the HOTS for controlling and regulating their thinking, learners use skills of Metacognition that use their knowledge of Metacognition about cognitive prosses (Schraw & Moshman, 1995). Metacognition skills can be seen as a procedural component of Executive or Metacognition (Brown, 1987; Paris & Winograd, 1990; Veenman, 2005). Metacognition skills is very important to manage the process of thinking and gives the relationship between the level of meta-knowledge about strategies and tasks and cognitive performance (Borkowski, Chan, & Muthukrishna, 2000; Schraw, 1998; Veenman, 2011). For example, learners need to plan a strategy which will be used HOT, based on the demands of the task, and then monitor and govern your use of that strategy.

Developmental study shows that after age 15 skill Metacognition generally are public (Van der Stel & Veenman, 2010, 2013; Veenman & Spaans, 2005; Veenman, Wilhelm, & Beishuizen, 2004). Public-domain aspect of Metacognition skills suggests that they may be easier to switch to a new domain and task. However, the development of skills in Metacognition occurs gradually and some learners may not spontaneously acquire MS a competent (Brown & DeLoache, 1978; Veenman, Kok, & Blöte, 2005). Veenman (2011) show that learners have skills in Metacognition at their disposal but failed to produce it appropriately can be aided by the cues and reminders. But the students who do not have skills in Metacognition might not get the benefit of cues and reminders. Learners with "deprivation" need to be instructed to use Metacognition Skills to be able to get them effectively (Veenman, 2011). Veenman refers to Metacognition skills instruction informed by using WWW & H regulations: "that means that learners should be instructed, modelled and trained when to apply the skills, why and how in the context of the task" (2011, p. 210). This means that knowledge Metacognition about Metacognition Skills plays an important role in the acquisition of skills in metacognition. Call this brings us full circle to the importance of Metacognition knowledge strategies in promoting HOT by proposing that learners can benefit from knowledge Metacognition strategy is not just about HOT, but also about Metacognition Skills required to successfully execute this strategy.

Therefore, it can be said more specific Metacognition makes it easy for someone to think more critically than conceptualizing Metacognition as a vast skills. In addition, a more specific model will help when applying higher-order thinking. The individual begins to use some meta level resource that serves as a bridge to reach the critical thinking. When the student is able to control the cognitive processes, they tend to be critical of the facts presented to them. So it can be dikatakab higher order thinking skills and Metacognition as the process of organizing knowledge and higher-order thinking serves as a refinement of knowledge, for students to have the skills of a high level of Metacognition of thinking needs to be applied in achieving the success of the process of thinking.

CONCLUSION

Based on this literature study it can be concluded that the ability of *Higher Order Thinking Skills(HOTS)* is a process thinking that requires students to manipulate information and ideas in a way that gives them the understanding and implications of new. Metacognition is the approach can be helpful when applying *Higher Order Thinking Skills(HOTS)* . The research on Metacognition is the knowledge, awareness and control of the process and the results of one's thinking. The individual begins to use some meta level resource that serves as a bridge to reach the critical thinking. When students are able to control their cognitive processes, they tend to be critical of the facts presented to them. So it can be said to be of higher order thinking skills and Metacognition as the process of organizing knowledge and higher-order thinking serves as a refinement of knowledge for students to have the skills of a high level of Metacognition of thinking needs to be applied in achieving the success of the process of thinking.

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APPLICATION OF LEARNING COOPERATIVE MODEL TYPE THINK PAIR SHARE TO INCREASE UNDERSTANDING MATHEMATIC CONCEPT PARTICIPANTS

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Abstract

The purpose of this research is to know the influence of cooperative learning model type Think Pair Share (TPS) to understanding the concept of mathematics and learning outcomes in learners. Understanding the concept is one of the competencies that play an important role in learning mathematics. By understanding the concepts expected students can be able to master other mathematical skills. But until now, concept comprehension is always a problem for the students so there is a need for research that can help teachers in improving students' concept understanding, and model of cooperative learning type Think Pair Share (TPS) is one of the learning model that can increase the understanding of learners. The research method used is research literature study that is by collecting various information about TPS. After conducting literature studies citing data on TPS from various sources so that to the suspicion that TPS can improve students' mathematical understanding.

Keywords: *Understanding concept, cooperative learning, Think Pair Share*

PRELIMINARY

Problems often faced by teachers in the learning process is that few students are actively involved in the learning process. Then, less interested students to discuss because the discussion activities conducted only learning in regular groups without the formation of groups by teachers. Therefore it is necessary to implement learning that can activate and develop student activities in expressing ideas and solving mathematical problems to improve the quality of the learning process of mathematics. The meaning of Sriati (1994: 4), reveals that the students' mistakes in working on math problems are a) The concept's mistake is to understand abstract ideas, b) Mistakes Strategies are mistakes that occur when students choose an improper path leading to a deadlock, and c) Count is an error counting mathematical operations.

The same thing disclosed by Wiyanto (2010) The mastery of student math in Indonesia is still low. This can be seen from the low achievement of Indonesian students who ranked 32 of 38 participating countries in 1999 and ranked 37 out of 46 participating countries in 2003. One cause is the ineffectiveness of the learning process.
An interview with a mathematics teacher at school revealed that the students did not understand the concepts of the material that had been taught. If the teacher gives a slightly different problem then the student will be confused in answering it. Also when teachers ask questions only some students respond to questions. Teachers have also

given students the opportunity to ask questions about materials that are not understood but less responsive.

From various problems found, the authors conclude that the need to solve the problem of understanding the concept of students. Hasnida (2011: 890) states that conceptual understanding allows students to solve problems in various forms, even highly capable students will be able to solve problems that have never been encountered before. For that we need a study to try out what learning models can improve or improve students' conceptual comprehension skills. Without the application of a good learning model, then the learning process will not be directed so that the learning objectives that have been set not achieved optimally. In addition, the process of learning in the classroom can not take place effectively and efficiently without the application of appropriate learning models.

Cooperative learning model can be an alternative to improve students' conceptual understanding (Kagan, 1989). Celikten, Ipekcioglu, Ertepinar, & Geban (2012) in his research also led to the conclusion that cooperative learning model can improve students' concept understanding better than traditional learning model. And ultimately cooperative learning can improve student learning outcomes (Russo, 2014). This is because the ability to work together well in this research. In addition, with this learning, students are more likely to explore their potential because students find themselves the concept of the material they are studying, so the concept is well embedded (Winda et al., 2012).

Based on the description above, we can estimate that the implementation of cooperative learning model Think Pair Share type is a learning that can improve understanding of mathematical concepts of learners so that in the end can improve their learning achievement.

RESEARCH METHODS

This study is a literature study. In this study the data collected from sources related to the topic under study. The topic raised in this research is the understanding of students' mathematical concepts and cooperative learning model Think Pair Share type. While the source data from this study comes from journals, articles, books, research reports, and the internet.

RESULTS AND DISCUSSION

One of the goals of mathematics learning is to develop conceptual understanding abilities. The ability to comprehend mathematical concepts is one of the determinants of the learning objectives of mathematics. If students can understand the concept well, it is expected that students are able to master other mathematical skills, such as: reasoning, problem solving and communication (Winda et al., 2012). Thus, the learning system implemented in the school should pay attention so that the concept can be embedded properly to the students. This leads to the necessity of choosing the right model of learning.

Think Pair Share cooperative learning model can be an alternative to improve understanding of mathematical concepts of learners. According to Ibrahim (2000: 26) cooperative learning steps think pair share type is Thingking (thinking), Pairing (pair), and sharing (sharing). The existence of the stage students present their work results and other students respond to the work of his friend can train students to express mathematical ideas. This learning model emphasizes that students can actively develop potential by creating groups consisting of two people who will create optimal interaction patterns, develop a spirit of togetherness, the emergence of motivation and foster effective communication. Through cooperative learning type Think Pair Share students can actively express themselves in classroom learning. In TPS students get more time thinking individually and in pairs to respond and help each other. In addition, students will also develop the ability to test ideas and understanding as well as comparing with the ideas put forward by other students so that social interaction can occur. Thus, it is expected that all students understand the material. Therefore, the application of cooperative learning model of TPS type can be an effort to improve students' concept comprehension ability.

This type of TPS was developed by Frank Lyman, et al. from Universtas Maryland in 1981. TPS type cooperative learning is one type of cooperative learning that is considered effective to change the atmosphere of the pattern of discussion in the classroom. According to Nurhadi (2004: 23) TPS is a learning structure designed to influence the pattern of student interaction in order to create a cooperative learning that can improve students' academic mastery and skills. TPS has a defined procedure to give students more time in thinking, answering, and helping each other.

Frank Lyman in Trianto (2009: 82) suggests that the steps (TPS) of TPS are (a) thinking, the teacher asks a question or problem associated with the lesson, and asks students to take a few minutes to think for themselves problems, (b) pairs, the teacher asks the students to pair up and discuss what they have gained, and (c) the sharing, the teacher asks the couples to share with the whole class they have been talking about.

Furthermore, in the opinion of Arends in Trianto (2009: 81) which states that the steps in the first TPS implementation is think (think) that the teacher ask a question or problem associated with the lesson, and ask students to use a few minutes to think Own answers or problems; Pair (pair) is the teacher ask students in pairs and discuss what they have gained. Interactions during the time provided can unify the answer if a question is asked or unites the idea when a specific problem is identified. Normally teachers give no more than four or five minutes to pair; And the last is a share (shared) that the teacher asks the couples to share with the whole class they have been talking about. This is effective until some couples get a chance to report.

With the model of cooperative learning type of TPS, students are given more opportunities to think, respond, and work independently and help other friends positively to complete the task, in accordance with the opinion of Lie (2004: 57) stating that TPS is one model of cooperative learning Simple that provides an opportunity for students to work alone and work with others. Excellence This learning model that is, able to optimize student participation. Furthermore, according to Kagan in Eggen and Kauchak (2012: 134) TPS is a group working strategy that asks individual students in a learning partner to first answer questions from the teacher and then share that answer with a colleague. In its application, TPS will be effective if each student actively participates in the TPS learning process. This is consistent with the opinion of Eggen and Kauchak (2012: 134) which states that the effectiveness of the TPS type cooperative learning model can occur if this learning model can invite responses from everyone in the classroom and can place all students in cognitively active roles , In addition each member of the couple is expected to participate so that this strategy reduces the "free passenger" tendency which can be

problematic when using group work. So, it can be concluded that the TPS learning begins with the Think process (thinking) that students first think individually to the problems presented by the teacher, followed by the pair stage (pairs), the students are asked to discuss with their partners about what he had thought Individually, and ends with a share, once an agreement has been reached on his or her mind, one partner shares with the class what is the agreement in the discussion and then continues with another pair until some couples can report on the experiences or knowledge they have.
Then, the advantages of the think-pair-share cooperative learning model are as follows: (a) allowing students to formulate and ask questions about the taught material as it indirectly derives samples of questions asked by the teacher, and the opportunity to think through the material taught ; (B) students will be trained to apply the concept for exchanging opinions and thoughts with their friends to gain agreement on solving problems; (C) students are more active in learning because they complete the task in groups, where each group consists of only 2 people; (D) students have the opportunity to present the results of their discussion with all students so that the ideas spread; (E) enabling teachers to monitor more students in the learning process (Hartina, 2008: 19).
Meanwhile, according to Muslimin Ibrahim (2000: 6), Think-Pair-Share method has advantages, among others: 1) Increase the time shedding on the task. 2) Improve presence. 3) Decreased dropout, 4) Apathy is reduced, 5) Acceptance of larger individuals, 6) More in-depth learning results, 7) Improve virtue, sensitivity and tolerance.

In addition, Fogarty and Robin (1996) stated that the teaching techniques of Think Pair Share have several advantages: 1) easy to implement in large classes, 2) giving students time to reflect the content of the subject matter, 3) giving the students time to Train opinions before sharing with small groups or classes as a whole.

Based on research result of Reysti Betharia Erinda (2016) with population of class X MIA SMA Negeri 1 Bandar Lampung, obtained by conclusion that model of cooperative learning type think pair share (TPS) have an effect on understanding student's mathematical concept. This can be seen from the understanding of mathematical concepts of students who get cooperative learning TPS type better than the understanding of mathematical concepts of students who get conventional learning.

The study by Abdullah abbas (2010) also resulted in the conclusion that cooperative learning can improve the understanding of mathematical concepts of students because in cooperative learning the teacher ensures the understanding of student concepts is better than in traditional learning. This is also in line with More (2005) and corroborates the results of research Abdul Rahim and Al Shakili (2005) As for measuring students' concept of understanding can be measured through 4 indicators, namely:

1. Redefine a concept
2. Present concepts in various forms of mathematical representation
3. Use, utilize and select certain procedures or operations
4. Apply the concept or problem solving

CONCLUSIONS AND SUGGESTIONS

This type of thinking pair share cooperative learning model can improve students' conceptual understanding ability better than traditional learning. This is because the model gives the learner a chance to exchange opinions with a friend after thinking for themselves and then followed by explaining in front of the class and receiving explanations from other friends. Thus, students will be more familiar with the concept being discussed. In addition, this learning model can form the character of students, namely tolerance, sensitivity, liveliness, and spirit togetherness. Based on this study, the authors suggest:

1. To improve the ability of understanding mathematical concepts of learners, teachers can apply cooperative learning model Think Pair Share type.
2. Researchers after this can observe the conceptual understanding of learners more deeply, and
3. To further examine the influence of Think Pair Share on other mathematical capabilities.

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THE INFLUENCE OF CONSTRUCTIVIST APPROACH TOWARD MATHEMATICAL CONCEPT UNDERSTANDING AND PROBLEM SOLVING SKILL OF 7TH GRADE STUDENTS AT SMP N 7 PADANG REVIEWED FROM COGNITIVE STYLE AND PRIOR KNOWLEDGE

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Abstract

The skill of problem solving and mathematical concept understanding of 7th grade in SMP N 7 Padang is low. It's caused by the learning activities that held by the teachers are not optimal, its tend to be conventional. Teacher must consider the different of cognitive style and prior knowledge of the students in designing learning activities. Formore optimallearning outcomes, teachers shoulduse another approachesthatcanhelpstudents get better skill in math, one of them is constructivist approach. The aims of this research are knowing the influence of constructivist approach on mathematical concept understanding and problem solving skill of the students in consideration of students' cognitive style and prior knowledge. This is experimental research that using two class to be compared. The results showedthat: 1) there is no significant difference of the students' concept understanding who learned by constructivist approach and conventional learning, 2) there is an interaction between prior knowledge and learning approach in mathematical concept understanding of the students, constructivist approach doesn't fit the students that have low prior knowledge 3) the problem solving skill of students' wholearned by constructivistapproach isbetter thanconventional learning.

***Keywords** – constructivist approach, problem solving skill, mathematical concept understanding, cognitive style, prior knowledge*

INTRODUCTION

The aims of mathematics learning are to train and develop students thinking skills. Through mathematics learning students are taught to think abstractly and an approach to do problem solving. Mathematics teaches strategies to solve problems, how to behave when facing problems and how to solve problems with different levels of complexity [1].

Problem-solving skills taught through mathe-matics learning is needed for students to be used in the world of work later. The world of work re-quires workers to be open to new ideas, adapt-able to change, overcome difficulties, understand patterns and solve problems, which is not a tra-ditional problem. Solving the problem requires a scientific method that demands logical, critical and creative thinking skills. Therefore, the learning of mathematics is very necessary for students.

In practice, mathematical learning in schools is overwhelmed with problems. Based on the data of another the research, the problem solving ability that should be developed by learning mathematics, in fact still low [2]. Problem-solving skills are the ability of students to solve complex and complex non-routine problems, with no direct procedure to solve them, one must experiment (an attempt) to find the solution [3].

The low ability of the students to solve the problem can be seen from the mistakes made by students when solving problems, such as mis-takes in interpreting the problem because of lack of understanding of the problems posed [4], the use of faulty operations, carelessness, and values that are mutually exchanged [2]. Some student difficulties when dealing with problem solving problems are students not knowing what ele-ments are known and being questioned from the problem, students having difficulties in solving math problems with specific strategies and explaining the outcome of problem solving [5], [6].

One of the causes of low student problem solving skills is the problem-solving approach used by students. Students do not understand the problem, they just search for keywords from the problem, then memorize the process to be done [4]. Students know many mathematical procedures, but do not know in what context the procedure can be used. Thus, their procedural knowledge still can not help them in solving the problem. This indicates another problem, that is, the students' mathematical soncept understand-ing is also low. Mathematical concepts under-standing is the ability of students to absorb the meaning of an abstract subject matter.

Students are not able to interpret and perform the correct procedures in solving a problem because of their less understanding of the concept. Students who understand the concept will know more than just separate facts and procedures. They know why mathematical ideas are important and in what context can be used [7]. Therefore, students will be able to understand the problem and devise a problem solving solution if they understand the concept used to solve the problem.

From the observations in the field, found many students who have problems with understanding the concept. Students feel dif-ficulties if the problem is not like the matter that exemplified by the teacher. They also have trouble deciding what concepts should be used to solve a problem on a test that contains many subjects. This, causing many students who fail in tests such as mid-semester exam and semester exam.

Many reasons behind the failure of students in learning mathematics. However, most of the reasons are related to the curriculum [8] and learning methods rather than the lack of stu-dents in learning. The current curriculum for mathematics learning still focuses on the ability of low-level thinking, which is evident from the evaluation tools provided. In addition, in general teachers in schools still use conventional me-thods in learning. In this study, conventional learning is meant the usual learning done by the teacher. Conventional learning is more relying on memorization, the selection of information is determined by the teacher, focusing on a par-ticular area, giving the students information up to the time it is needed.

Based on the observations, the learning ac-tivities are more dominated by teachers. Classroom activities are highly dependent on textbooks. However, not all activities in the textbooks are conducted. For example, teacher Will pass through the troubleshooting section and will only perform a simple concept discovery activity. In addition, textbooks that are used have a systematic material that is less coherent so that students have difficulty under-standing the concept of the undertaken acti-vities. As a result, students can not construct and interpret the gained knowledge.

Besides the conventional methods that teach-ers often use, there are many other methods can be used. However, there are things that need to be considered before choosing the learning method, namely cognitive style and prior know-ledge of the students. Elements that students understand in the past, how students under-stand and organize concepts and rules students use to understand things all have an influence on the formation of their new knowledge. Thus, teachers need to consider it before using a teaching method.

Teachers need to choose a teaching strategy that fits the student's cognitive style, so that learning provides optimal results. Cognitive style is the attitude or way a person in organizing information and experience that determines the way a person in receiving, remembering, think-ing and solving problems. The cognitive style is related to the process by which students orga-nize, receive and transmit information and behavior. There are two types of cognitive styles: field independence (FI) and field dependence (FD).

Students with FI cognitive style have charac-teristics such as analytical, competitive, indivi-dualistic, can solve complex problems, remem--ber information, separate facts and not facts, relevant and not, impose structures when the content is lacking, and have a higher working memory capacity, have intrinsic motivation and are not easily distracted. Of the many advantages of students with the FI cognitive style, they have a lack of having a low interpersonal quality [9].

In contrast, students with FD cognitive styles have high interpersonal qualities. However, they have lower memory work capacity, difficulty in solving complex problems, easily distracted, less intrinsic motivation, difficulty in remembering information and they are less flexible so they can't impose a structure when the content is lacking [9].

If the teaching methode matched the stu-dent's cognitive style, the learning process became more productive and valuable [9]. The incompatibility of teaching methode with cog-nitive style is not important for FI students, but this is very important for students with FD cognitive style [10]. The things that need to be considered by the teachers in designing a lesson related to differences in cognitive style of the student is in teaching teachers should teach stra-tegies that can be used for many contexts and do the learning in groups. Students with FD cogni-tive style have a smaller working memory capacity than FI students and are more rigid. FD students find it difficult to keep new knowledge in their memory and they are inclined to use fixed strategies to solve problems. FD students need encouragement and guidance to help them remember the knowledge they have. Thus, group learning with FI students fits very well with FD students. In addition, if the FD students are assisted in receiving and processing information in group learning, then FI students also help to improve the quality of their interpersonal.

Before doing the learning, teachers need to check the knowledge and skills of students, what prerequisite materials they have not mastered, which need a little review and what is not neces-sary to be reviewed again. Based on the infor-mation, teachers can design appropriate learn-ing, so that students can follow the learning from the beginning with a stock that is almost the same.

In addition to the cognitive style, in designing the learning teacher's should also pay attention to the prior knowledge of students. Prior knowledge is a level of ability that has been owned by students before following the process of learning. Prior knowledge has very important role in improving the meaningfulness of teach-ing, which in turn has an impact in facilitating the internal processes that take place within students when learning [11].

To enable students to construct a new understanding, they must recognize the relation to the knowledge they already possess. In addi-tion, the higher the students' prior knowledge, the easier it will be for them to organize their knowledge and the less students need the teacher's instruction in learning.

The skills that the student demonstrates as prior knowledge are individual. To know him should be done individually as well. Know prior knowledge can be done through interviews or tests. Teachers' tests can be a tool to familiarize themselves with prior knowledge. Another way of determining prior knowledge is through learning analysis. From the analysis of learning made can be known hierarchy level of ability or mastery of subject matter. On this basis it can be stipulated that a lower level of subject matter to be taught is a prior knowledge.

Based on the differences that these students have, teachers need to consider it in their learn-ing to provide optimal results, especially on problem-solving and students mathematical con-cept understanding. Teachers need to apply al-ternative learning approaches other than those commonly used by teachers.

Teaching with knowledge transfer is no longer effective to be done in an effort to overcome the low of problem-solving skills and mathematical concept understanding of the stu-dents. Learning will be more successful if students actively construct their own know-ledge. The knowledge construction process is necessary to organize knowledge that matches the student's life experience, so it can be used when dealing with new challenges and expe-riences. Through the construction process stu-dents are taught how to think well, so they can use that way of thinking to face a new pheno-menon. Learning that apply the process of this construction of knowledge is a constructivism approach.

Learning with constructivist approach is the implementation of learning that done by involv-ing students actively in constructing knowledge based on the knowledge that they already owned. The constructivism expert states that knowledge is formed in the minds of students as they seek to organize their new experiences based on the cognitive framework already exist-ing in their minds. Students are directed to pro-vide their ideas in solving problems on learning with constructivist approach. The emergence of many ideas in a class of the same material further stimulates the students to construct their knowledge in more detail and complete.

The constructivist approach places the student as a centered, the teacher acting as a facilitator that creates an atmosphere of thought for the students. The atmosphere of thought created in the form of problems close to the daily life of students. The constructivist approach allows students to develop their understanding and problem-solving skills through various acti-vities and the results that obtained in accor-dance with their progress.

Mathematical learning with constructivist approach is done by applying the principles [12], as follows:

1) Activation of prerequisites knowledge
   Students are reminded of their prerequisite knowledge to facilitate understanding of sub-sequent material, by providing some quest-ions that explore the prerequisites.
2) The acquisition of new knowledge

Students are given issues to be discussed as groups to try to find answers and give them a chance to find Ideas. Then the results are discussed.

3) Idea gathering
Teacher leads class discussions to collect student ideas from different groups. Students are asked to construct ideas from each group to be agreed upon and correct. The teacher acts as a facilitator in constructing the new idea.
4) Stabilization of ideas
Students are asked to solve a given mathe-matical problem (quiz/test/exercise), to con-solidate the knowledge they have already established.
5) Reflection
Students are directed to make a summary of material are already studied and the teacher checks the correctness of the concept by ask-ing questions, then giving individual assign-ments/homeworks that will be collected at the next meeting and the results assessed to find out how far students understand the concept.

The implementation of learning with a constructive approach makes students personal-ly involved in the learning process and make students develop their thinking skills. FD stu-dents tend to have difficulty keeping new know-ledge in their memory and are likely to use fixed strategies to solve problems. Learning with cons-tructivist approach is more emphasized on the development of thinking ability not just pro-cedural capability. Students are trained to deve-lop their ability in approaching a problem. Therefore, FD students do not need to memorize much more for each different problem condition, because they have been trained in approaching to solve the problem.

In addition, in the learning with the cons-tructivist approach the activity begins with the activation of prerequisite capability. It aims to equate students 'understanding to cope with the diversity of students' prior knowledge level. Ena-bling this prerequisite capability helps students with cognitive style FD Which has low memory working capacity. Enabling pre-requisite know-ledge makes retrieval of information from me-mory easier. Students' understanding of the prerequisite material, is expected to be the basis for them to construct new, more meaningful knowledge.

Learning with constructivist approach is done in groups. This is because the students have their respective views of the knowledge they are constructing. Through discussion in groups stu-dents can compare and analyze their knowledge whether it is correct or not. Learning in a group needs to be done if the learning objective is to build a conceptual understanding or learn stra-tegies to solve more challenging problems.

In group learning FI and FD students will be combined in one group. This will make learning more effective and reduce the dependence of FD students on guidance and direction from teachers and train them to develop their own thinking. Group learning has a positive effect on students' social skills and mathematics learning.

The constructivist approach has a positive effect on FI students who have low interpersonal skills, ie on social skills, ethics and student personality development [13]. Students who are usually shy and closed, and less concerned with the environ-ment becomes more active and expressive. The student demonstrates the desire to engage in his learning community and shows a caring attitude towards his friend, and patiently and diligently teaches his friends.

Based on the above explanation, this research is titled “The Influence of Constructivist App-roach toward Mathematical Concept Under-standing and Problem

Solving Skill of 7th Grade Students at SMP N 7 Padang Reviewed from Cognitive Style and Prior Knowledge".

METHOD

The research design that used was factorial design, by comparing the result of test about mathematical concept understanding and prob-lem solving skil of the students based on cogni-tive style (FD & FI) and prior knowledge(Low & High). This research uses two groups, namely experiment and control. The experimental group was taught using a constructivist approach, while the control group was conventional learn-ing. At the end of the lecture the two groups were given a mathematical concept understanding and problem soving test.

The population in this study is the 7th grade students of SMP N 7 Padang. The technique to take the sample is random sampling method. The samples that selected is class VII2 and VII3 as experimental groups and classes VII6 and VII8 as control groups.

The instruments used to collect data in this research are test about concept understanding and problem-solving skill, and GEFT (Group Embedded Figure Test). The cognitive style of students is determined based on this GEFT. The test subjects are expected to find simple images on 18 complex images within the allocatted time (12 minutes). Based on the correct number of students answered, the score on GEFT has a range of 0 (most FD) up to 18 (the most FI). To group students based on their prior knowledge, based on students' examination of Lines and Angles material. Students who scored above the average, which is 57 were classified to a high prior knowledge group, and conversely the low prior knowledge group.

The conceptual understanding test consists of 8 questions in the form of essays on Triangle and Quadrilateral materials, one for each of the following indicators, 1) reiterating the learned concepts, 2) classifying the objectives based on the requirements (3) identifying the nature of operations or concepts, 4) applying logical concepts, 5) giving examples or not examples of learned concepts, 6) presenting concepts in various forms of mathematical representation, 7) linking various concepts in mathematics as well as outside mathematics, 8) develop the necessary conditions and / or sufficient terms of a concept.

While the problem-solving test consists of 2 essay questions, with assessment in accordance with the infiser, 1) organizing the data and selecting relevant information in identifying the problem, 2) presenting a systematic problematic formulation in various forms, 3) using or develop problem-solving strategies, 4) interpret the results of answers obtained to solve problems.

RESULT

The data from the research is given in the Table 1.

Table 1

The Descriptive Statistics of The Result of Mathematical Concept Understanding Test

	Concept Understanding (Y_1)			
	Cognitive Style FI (A_1)		Cognitive Style FD (A_2)	
	Exp (X_1)	Cont(X_2)	Exp (X_1)	Cont(X_2)
N	14	12	53	50
$Min.$	14,29	35,71	0,00	7,14
$Max.$	92,86	92,86	100	78,57

$\bar{x}$	57,65	60,12	46,89	51,42
$St.Dev.$	2,35	1,7	2,32	1,35
	High Prior K. (B_1)		Low Prior K. (B_2)	
	Exp (X_1)	Cont(X_2)	Exp (X_1)	Cont(X_2)
N	37	30	30	32
$Min.$	21,43	28,57	0,00	7,14
$Max.$	100	92,86	71,43	78,57
$\bar{x}$	60,81	57,14	34,76	49,29
$St.Dev.$	2,06	1,47	1,85	1,35

From the results of the calculation, the average value of the highest concept of under-standing is obtained by the experimental group with high prior knowledge. The worst results were obtained by students of the experimental group with low aw-al capabilities.

In general, without distinguishing cognitive styles and prior knowledge, when compared to an understanding of the concepts of students learning with constructivist approaches and those with conventional learning did not differ significantly. This happens because the first, less used of the students who learning using constructivist approach, so much time required to construct student knowledge, while the time available is very limited. Therefore, the process of constructing knowledge does not work optimally. Second, this is due to the quantity of tasks assigned to different experiment and control class students. Control class students do more individual tasks than experimental class students, due to the lack of number of classroom meetings.

The average test results of students' con-ceptual understanding with FI cognitive style who taught by conventional show better out-comes than students who learn with constructivist approaches, although they do not make a significant difference, after being tested by U-Test. Students with FI cognitive style are not significantly affected by the teaching methods used by teachers [10]. Therefore, they will get almost the same achievement although the learning method is different.

The mean value of students' conceptual understanding with FD cognitive style who taught by conventional is higher than that of students learning with constructivist approach, but the difference in achievement is not very significant based on U-Test statistics. If we traced the cause, this happens because the lack of effective discussion activities that take place. Many students do not discuss but only copy the work of friends. This is also related to students' difficulties adjusting to a new learning approach, so that the material learned at the beginning of the meeting is poorly understood by the students.

After testing to see the interaction between the cognitive style and the learning approach in influencing the understanding of the concept, it turns out the result obtained no interaction. This means that learning approaches and cognitive styles together do not influence the students' mathematical concepts understanding

Students who learn with a constructivist approach that has a high prior knowledge obtain a higher mean value of conceptual under-standing than students who learn conven-tionally. However, the differences shown are not very significant, based on the U-Test performed. This means that the constructivist approach does not give effect to the conceptual under-standing of students who have high prior knowledge.

Conceptual understanding of students that has low prior knowledge that is studied conven-tionally is higher than students who learn with constructivist approach. Learning with a top-down in constructivist approach demands stu-dents to master the prerequisite knowledge in order to construct knowledge of the problems they are concerned with. It is very hard for students with low prior knowledge. Despite the activation of knowledge prerequisite activities, but this does not necessarily make students can use it in solving problems to construct new knowledge. Therefore, learning with construc-tivist approach does not have a positive impact on students with low prior knowledge.

After testing the interaction between the learning approach and the prior knowledge, the result showed there is an interaction between the learning approach and the students 'early ability to influence the students' math concept. Students with low prior knowledge are better taught with a conventional approach than with a constructivist approach.

The result of problem solving test is given in Table 2.

Table 2
The Descriptive Statistics of The Result of
Problem Solving Test

	Problem Solving Skill (Y_2)			
	High Prior K. (B_1)		Low Prior K. (B_2)	
	Exp (X_1)	Cont (X_2)	Exp (X_1)	Cont (X_2)
N	37	30	30	32
$Min.$	0,00	0,00	0,00	0,00
$Max.$	93,75	85,71	62,5	71,43
$\bar{x}$	47,8	38,57	33,33	25,44
$St.Dev.$	1,98	2,97	1,58	2,43
	Cognitive Style FI		Cognitive Style FD	
	Exp (X_1)	Cont (X_2)	Exp (X_1)	Cont (X_2)
N	14	12	53	50
$Min.$	0,00	7,14	0,00	0,00
$Max.$	75	85,71	93,75	85,71
$\bar{x}$	40,44	35,79	41,98	30,99
$St.Dev.$	2,08	2,31	1,93	2,87

The mean value of student problem-solving skill with high prior knowledge that learn with constructivist approach is the highest average among the other groups. While the lowest average obtained students who learn conventionally have low prior knowledge.

In general, students' problem-solving skill that learn with constructivist approaches are higher than students learning with conventional learning. Students who study by conventional approach generally only answer up to the stage of determining the relevant information from the given problem. Most of them can not locate relevant information from the given problem, resulting difficulties in designing a strategy to solve the problem. Therefore, many control-class students can not solve the given problem. Unlike control class students, experimental class stu-dents can generally determine the relevant information of the problem, so they can con-struct a problem-solving strategy. However, most of them are difficult in determining the right strategy and many who make mis-calculations.

The average of students' problem-solving test results with FI cognitive style learning with constructivist approaches is higher than for con-ventional students. However, the difference is not very significant, based on the results of U-Test. The cause of this is the timing of the test is not appropriate, which is close to school hours, so students do not concentrate anymore run the test.

Learning with constructivist approach greatly affects student problem-solving abilities with FD cognitive style, seen from higher results obtained by experiment class students compared to control class students.

The result of interaction test between learning approach and cognitive style is obtain-ed by the result that there is no interaction between the learning approach and the cognitive style of the students in influencing students' mathematical problem solving skills. This shows that there is no effect of learning approach and cognitive style together with students problem solving skills.

The mean value of students 'problem-solving test results with high prior knowledge learning with a constructivist approach is higher than that of conventional students, but the difference is not significant, based on T' Test statistics. This is thought to be caused by the difference in timing of the test. The experimental class students perform the tests at the end of the lesson where there are some disorders that make them less focused on the tests. While the control class students do the test in a fairly quiet condition, did not experience much interference.

Learning with constructivist approach does not significantly affect student with low prior knowledge problem solving skill. The average grade of experiment class students is higher but does not make a significant difference, based on T 'Test statistics. Low prior knowledge students feel a bit difficulty attending classes because of their lack of prior knowledge to develop stra-tegies for solving problems. Therefore, the dif-ferences generated by experiment and control class students are not particularly noticeable.

For the interaction test between the learning approach and the prior knowledge, the result of the lack of interaction between the learning approach and the student's prior knowledge in influencing the problem solving skill of the students. Although students' prior knowledge are different, students who learn with construc-tivist approach provide better problem-solving results than students studying with conventional approaches. This is caused by the differences in the frequency of students in working on problem solving problems. The more students work on problem-solving problems, the better their problem-solving skill.

CONCLUSION

The conceptual understanding of students with high prior knowledge, who have FI or FD cognitive styles who learn with constructivist approach and conventional are not different significantly. While for students with low prior knowledge have a higher understanding of the concept if learn with conventional approach, compared with those learning with constructivist approach.

There is an interaction between prior knowledge and learning approach in influencing students' conceptual understanding. Students with low prior knowledge are better off if learning with a conventional approach.

In general, regardless of prior knowledge and student cognitive style, students' problem-solving skill that are studied with the cosntructivist approach are higher than those studied conventionally. For students with high and low initial skills as well as students with FI cognitive styles, their problem-solving skills are similar between those studied with constructivist approaches and those with conventional approaches. As for students with FD cognitive style, their problem-solving skills are higher when learning by constructivist approach than those studied conventionally.

There is no interaction between cognitive style, prior knowledge and learning approaches in influencing students problem solving abilities.

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CLASSIFICATION BIDIKMISI SCHOLARSHIP AWARDEE IN FMIPA UNP USING BIPLOT ANALYSIS

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Abstract

Bidikmisi scholarship is one of the cost assistance from Indonesian government to student's candidate who is weak from economic point of view but having a potential academic ability to finish their education in higher level (university/institute) on time. Universitas Negeri Padang (UNP) is one of university who organize that scholarship. Aim of this study to see the map of Bidikmisi scholarship awardee for each study program at FMIPA based on indicators which are required using Biplot Analysis. Indicators which used are parents income less than minimum wages average (UMR) (X_1), one of both parents not work (X_2), house owner (join/rent) (X_3), family dependent more than 4 people (X_4), and house area less than 50m² (X_5). Result of the analysis are each study programs at FMIPA having the same characteristics, except Physics and Statistics. The main characteristic for them is their parent's income less than UMR. But for Physics and Statistics, the working status of their parents who one/both of their parents not work is the main characteristic of awardee. The goodness of fit of biplot is 99%.

Keywords: *Bidikmisi Scholarship, Biplot Analysis, Goodness of Fit, R*

INTRODUCTION

Study in the higher education (university/institute) is a wish of each high school graduate. But not all of them can do that because of economic reason. Indonesian government give a scholarship for each students having economic problem but having a good ability to complete the course on time in the university/institute. It scholarship is Bidikmisi.

Criteria for candidate to be an awardee of Bidikmisi Scholarship based on the rule of Ministry of Higher Education (Ristekdikti). Some criteria which are given by Ristekdikti (2017) are less than 21 years old when submit an application; unable in economic sides which means awardee of Beasiswa Siswa Miskin (BSM/ poor students scholarship) or owner of Kartu Indonesia Pintar (KIP/ Indonesian Clever Card) or equivalent or gross income of parents (both) maximize IDR 3.000.000 and/or parents income divided by family dependent is less than IDR 750.000 per month; parents education maximize bachelor/fourth diploma; and having good academic ability based on reference from high school head master. Bidikmisi scholarship are available for state and private higher education (university/institute).

Universitas Negeri Padang is one of organizer of Bidikmisi scholarship. Each awardee receive monthly fees on IDR 600.000 and discharge of tuition fees for 8 semester for bachelor awardee and 6 semester for third diploma awardee.

Based on the previous criteria explained, we describe the characteristic of Bidikmisi scholarship awardee at FMIPA UNP using Biplot Analysis. Biplot firstly introduce by Gabriel on 1971. It is a multivariate descriptive analysis which shows the conditions of awardee based on it indicators. Matjik (2011) explain that we can find some information based on biplot analysis, they are neighborhood among variables, relation among variables and variable value on an object. Object of research is Bidikmisi scholarship awardees in FMIPA UNP in 2016 academic year. Thus, the aim of this study is to see the map of Bidikmisi scholarship awardee for each study program at FMIPA based on indicators which are required using Biplot Analysis. The indicators are parents income less than minimum wages average (UMR) (X_1), one or both parents do(es) not work (X_2), house owner (join/rent) (X_3), family dependent more than 4 people (X_4), and house area less than 50M^2 (X_5). This paper is organize as follows. First section is introduction and continue by material and method, statistical analysis which is used related to Biplot analysis for modelling the characteristics of Bidikmisi scholarship awardee in FMIPA UNP in 2016 academic year. In the third part we show the result of the study and in the last we give a discussion room.

MATERIAL AND METHODS

Research goal is map the characteristics of Bidikmisi scholarship Awardee in FMIPA UNP 2016. There are 180 students receive Bidikmisi scholarship scholarship in 2016. They are distributed into 9 study program which is 8 of them are bachelor program and one the others is vocational program which is third diploma program. Bachelor program in FMIPA UNP are Mathematics Education, Physics Education, Chemistry Education, Biology Education, Mathematics, Physics, Chemistry and Biology. The third diploma program in FMIPA UNP is Statistics.

Research method is based on Udina (2005) with a general layout of computation involved in Biplot like Figure 1. Computations start from a data matrix X that is frequency matrix of selected indicators of Bidikmisi scholarship. Then a singular value decomposition extracts the dimensions conveying most of the variability of the information included in the proportion of each awardee in each study program data matrix. The final step consists in scaling the resulting vectors and points to include them in Biplot.

Matjik (2011) gives information and interpretation of biplot analysis are as follows.

a. Correlation between each variables described as a directed arrow. Two variables having positive correlation if angle between both variables are acute, and if its angle is obtuse, it means that they have negative correlation and also if they differ in right angle explain that no correlation between both variables.
b. Variance of variables sketch as length of vector. Longer the vector, bigger the variances among variables and vice versa shorter the vector, smaller the variances.
c. Neighborhood among object is sketched as objects having the same characteristics. Nearest the object, having alike characteristic.
d. Variable's value on object detected from the relative position amongst variable and object. Object in a side with variables having the value upper average. If it have opposite direction, the value under average.

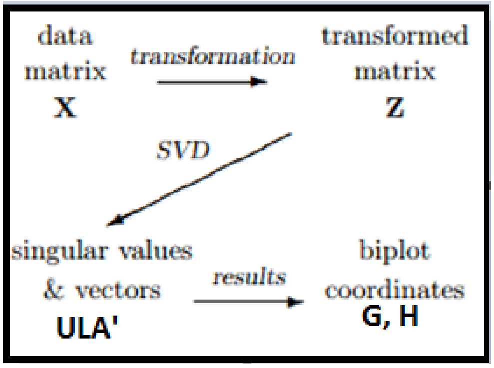

Figure 1. General layout of computation involved in Biplot

Data is showed using a matrix, say matrix $\boldsymbol{X}$ having p variables and n object as follows.

$$\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

Biplot is a multivariate analysis based on Singular Value Decomposition (SVD). Jolliffe (2002) tells that biplot provide plots of the n observations, but simultaneously they give plots of the relative positions of the p variables in two dimensions. Kurniawati (2014), the direct approach for determining the singular value of matrix of $n \times p$ dimension, consist of n objects and p variables corrected into its means and also having r rank. It can be write as $\boldsymbol{X} = \boldsymbol{ULA}'$. Matrix $\boldsymbol{U}$ and $\boldsymbol{A}$ respectively have $n \times r$ and $p \times r$ dimension, so $\boldsymbol{U}'\boldsymbol{U} = \boldsymbol{A}'\boldsymbol{A} = \boldsymbol{Ir}$. Matrix$\boldsymbol{L}$ is a diagonal matrix $r \times r$ with entries on its diagonal is square root of eigenvalue of $\boldsymbol{X'X}$ matrix, they are $\sqrt{\lambda_1} \geq \sqrt{\lambda_2} \geq \cdots \geq \sqrt{\lambda_r}$ or in other words entries of matrix $\boldsymbol{L}$ is a singular value of matrix $\boldsymbol{X}$and column of matrix $\boldsymbol{A}$ is eigenvector of $\boldsymbol{X'X}$. For column of matrix U is $u_i = \frac{1}{\sqrt{\lambda_i}} a_i, i = 1,2,\ldots,r$ for a_i is column of matrix $\boldsymbol{A}$ and λ_i is i-th eigenvalue.

Jollife(2002) define $\boldsymbol{L}^{\alpha}$for $0 \leq \alpha \leq 1$ and $\boldsymbol{G} = \boldsymbol{UL}^{\alpha}$ and also $\boldsymbol{H}' = \boldsymbol{L}^{1-\alpha}\boldsymbol{A}'$, so that $\boldsymbol{GH}' = \boldsymbol{UL}^{\alpha}\boldsymbol{L}^{1-\alpha}\boldsymbol{A}' = \boldsymbol{ULA}' = \boldsymbol{X}$. For Bilpot interpretation we choose $\alpha = 0$ and $\alpha = 1$. If $\alpha = 0$, we have $\boldsymbol{G} = \boldsymbol{U}$ and $\boldsymbol{H}' = \boldsymbol{LA}'$ so that $\boldsymbol{X}'\boldsymbol{X} = (\boldsymbol{GH}')'(\boldsymbol{GH}') = \boldsymbol{HH}' = (n-1)\boldsymbol{S}$ where $\boldsymbol{S}$ is variance-covariance matrix of matrix $\boldsymbol{X}$.

If $\alpha = 1$ we have $\boldsymbol{G} = \boldsymbol{UL}$ and $\boldsymbol{H} = \boldsymbol{A}$ so that $\boldsymbol{XX}' = (\boldsymbol{GH}')(\boldsymbol{GH}')' = \boldsymbol{GG}'$. Matjik (2011), matrix $\boldsymbol{GG}'$is an Euclid distance between g_i and g_j which are same to object x_i and x_j. Matrix $\boldsymbol{X}$approach in two dimension reach $\boldsymbol{G}$and $\boldsymbol{H}$ matrices which are $\boldsymbol{G}$ is coordinate points of n objects and $\boldsymbol{H}$is coordinate points of p variables as follows.

$$G^* = \begin{bmatrix} g_{11} & g_{12} \\ \vdots & \vdots \\ g_{i1} & g_{i2} \\ \vdots & \vdots \\ g_{n1} & g_{n2} \end{bmatrix} \text{ and } H = \begin{bmatrix} h_{11} & h_{12} \\ \vdots & \vdots \\ h_{i1} & h_{i2} \\ \vdots & \vdots \\ h_{p1} & h_{p2} \end{bmatrix}$$

Measure of variance which explain by Biplot define by $\rho^2 = \frac{\lambda_1 + \lambda_2}{\sum_{i=1}^{p} \lambda_i}$ where λ_1 and λ_2 are the first and second biggest eigenvalue and λ_i is the ith eigenvalue of $\boldsymbol{X'X}$. Sumertajaya

(1997) explain that the nearest the variance coefficient to one, Biplot shows better information of the real data.

RESULTS AND DISCUSSION

FMIPA is one of the faculty which students receive Bidikmisi Scholarship in UNP. Data of number of Bidikmisi scholarship awardee in each study program can be seen in Table 1.

Table 1.Number of Students in FMIPA UNP in Academic Year 2016 who Receive Bidikmisi Scholarship

Study Program	**Gender**		**Sum**
	Men	Women	
Biology	6	11	17
Physics	8	11	19
Chemistry	4	13	17
Mathematics	4	15	19
Biology Education	1	26	27
Physics Education	4	22	26
Chemistry Education	3	22	25
Mathematics Education	6	21	27
Statistics	0	3	3
Sum	**36**	**144**	**180**

Source: UNP Student's Welfare and Alumni Division

Greatest number of Bidikmisi Scholarship awardee are education study program. It cause the number of the students for each study program. Education study program, like Mathematics Education, Physics Education, Chemistry Education and Biology study program have students more than 100 people. It can be seen in Table 2.

Tabel2. Number of Students for Each Study Program in FMIPA UNP Academic Year 2016

Study Program	**Gender**		**Sum**
	Men	Women	
Biology	21	64	135
Physics	22	44	66
Chemistry	20	78	98
Mathematics	12	69	81
Biology Education	6	117	123
Physics Education	12	101	113
Chemistry Education	20	108	128
Mathematics Education	22	113	135
Statistics	8	51	59
Sum	**143**	**745**	**938**

Source: http://sie.unp.ac.id/index.php/laporan/terdaftar_rekap

Based on Table 1 we see that number of awardee for each study program are different. Because of that situation, we transform the data into its proportion, which is number of awardee in each study program having i-th indicator divided by the number of awardee in that study program, where $i = 1,2, \dots, 5$. Proportion for each condition are shows in Table 3 as matrix of data which is X with 9 rows and 5 columns. The variable of research are as follows.

X_1 = parent's income less than minimum wages average (UMR)
X_2 = one or both parents not work
X_3 = house owner (join/rent)
X_4 = family dependent more than 4 people
X_5= house area less than 50 m^2.

Table 3. Proportion of Bidikmisi Scholarship Awardee for Each Indicators

Study Program	X_1	X_2	X_3	X_4	X_5
Biology	0.88	0.76	0.47	0.18	0.76
Physics	0.89	0.84	0.53	0.21	0.42
Chemistry	1.00	0.76	0.41	0.24	0.88
Mathematics	0.95	0.79	0.53	0.32	0.58
Biology Education	0.93	0.74	0.48	0.26	0.78
Physics Education	1.00	0.73	0.46	0.19	0.58
Chemistry Education	0.92	0.72	0.60	0.28	0.64
Mathematics Education	0.96	0.63	0.59	0.30	0.56
Statistics	0.67	1.00	0.33	0.00	0.33

From Table 3 we know that parents of all Chemistry and Physics Education's awardee have income lower than minimum wages average (UMR), and one or both parents of all awardee of Statistics study program do not work. It means that they really need this scholarship for continuing their study.

Analysis data using Biplot analysis is started from finding Singular Value Decomposition of data matrix that shows by Table 3. SVD of data matrix $\boldsymbol{X} = \boldsymbol{ULA'}$. Matrix L is singular value of matrix X which is a diagonal matrix of square root of its eigenvalue. Eigenvalue of matrix X are

{ 18.941978167 0.296029313 0.126669394 0.019067470 0.007855656 }

Matrix L will be

```
          [,1]      [,2]      [,3]     [,4]       [,5]
    [1,] 4.352238 0.0000000 0.0000000 0.000000 0.00000000
    [2,] 0.000000 0.5440858 0.0000000 0.000000 0.00000000
L = [3,] 0.000000 0.0000000 0.3559064 0.000000 0.00000000
    [4,] 0.000000 0.0000000 0.0000000 0.138085 0.00000000
    [5,] 0.000000 0.0000000 0.0000000 0.000000 0.08863214
```

Matrix $\boldsymbol{U}$ consist of column which define by $u_i = \frac{1}{\lambda_i} a_i, i = 1,2, \cdots ,5$ and a_i is column of matrix $\boldsymbol{A}$ and also λ_i the ith eigenvalue matrix $\boldsymbol{X}$

U =

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	-0.3377553	0.116687958	0.34486730	-0.27920443	0.42853309
[2,]	-0.3211085	-0.319985680	-0.35141060	0.01803295	-0.05128508
[3,]	-0.3644543	0.299719918	0.51372082	0.24223971	-0.26552401
[4,]	-0.3434130	-0.005198261	-0.25299898	-0.09450072	-0.72582832
[5,]	-0.3481569	0.225540593	0.23277706	-0.20535909	-0.14093243
[6,]	-0.3333083	0.004043263	-0.07634676	0.77218158	0.26199344
[7,]	-0.3404832	0.129246870	-0.24140550	-0.45535533	0.27613960
[8,]	-0.3273721	0.189611790	-0.47876678	0.06213009	0.22265730
[9,]	-0.2768435	-0.831018497	0.28662056	-0.06681212	0.04547108

Matrix $\boldsymbol{H}'$ is a matrix that is constructed by $\boldsymbol{H}' = \boldsymbol{L}^{1-\alpha}\boldsymbol{A}'$ for $\alpha = 0$ as identifier of Biplot analysis.

H' =

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	-2.743808990	-2.30389369	-1.46960258	-0.67298623	-1.868936077
[2,]	0.070627778	-0.40507831	0.03068338	0.17655761	0.307958649
[3,]	-0.085437914	0.08518029	-0.20374135	-0.13459421	0.229102458
[4,]	0.099964954	-0.03140024	-0.07440899	-0.03411190	-0.037258328
[5,]	0.005595826	-0.02106604	0.04560205	-0.07237213	0.007955648

Because we use $\alpha = 0$, we have $G = U$ and $H' = LA'$. And G_2 and H_2 matrices are Biplot coordinate which explain first and second principal component of object and variables in two dimension, they are

```
> obj<-G[,1:2]
> obj
           [,1]         [,2]
 [1,] -0.3377553  0.116687958
 [2,] -0.3211085 -0.319985680
 [3,] -0.3644543  0.299719918
 [4,] -0.3434130 -0.005198261
 [5,] -0.3481569  0.225540593
 [6,] -0.3333083  0.004043263
 [7,] -0.3404832  0.129246870
 [8,] -0.3273721  0.189611790
 [9,] -0.2768435 -0.831018497
> var<-H[,1:2]
> var
          [,1]        [,2]
[1,] -2.7438090  0.07062778
[2,] -2.3038937 -0.40507831
[3,] -1.4696026  0.03068338
[4,] -0.6729862  0.17655761
[5,] -1.8689361  0.30795865
```

Biplot of Bidikmisi scholarship awardee of FMIPA UNP in 2016 academic year shows in Figure 2.

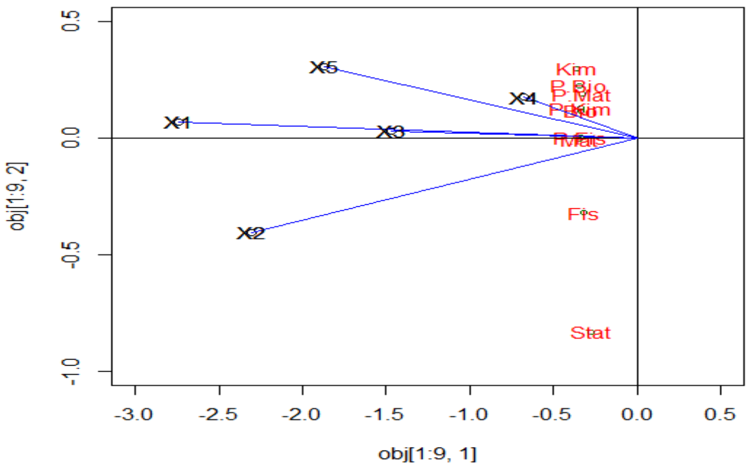

Figure 2. Biplot of Bidikmisi Scholarship Awardee in FMIPA UNP in 2016 academic year

Based on Figure 2, we see that all characteristic of Bidikmisi scholarship awardee in FMIPA UNP in academic year 2016 having positive correlation among each indicators. It seen that direction of each arrow which represented characteristics of Bidikmisi Scholarship awardee for each study program are into the left side. Size of angle of each indicator vector are less than 90^0 which explain by correlation matrix. Correlation matrix also show that correlation of it are positive like below

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	1.0000000	0.9980456	0.9997526	0.9971588	0.9982712
[2,]	0.9980456	1.0000000	0.9979578	0.9905958	0.9939072
[3,]	0.9997526	0.9979578	1.0000000	0.9970494	0.9970063
[4,]	0.9971588	0.9905958	0.9970494	1.0000000	0.9976375
[5,]	0.9982712	0.9939072	0.9970063	0.9976375	1.0000000

Beside the previous, in Figure 2 we also see that the length of vector which represented the measure of variance of Bidikmisi Scholarship indicators are different. Vector of X_1 which is parent's income less than minimum wages average (UMR)is the longest one. It tells that each awardee of Bidikmisi Scholarship in FMIPA UNP for all study program based on parent's income having high variety.Descriptively, we can see in Table 3 that proportion of Bidikmisi Scholarship awardee from Statistics is the smallest one, but the other study program having similar one. The shortest vector of biplot is X_4 which is family dependent more than 4 people. It means, characteristics for all study program in FMIPA UNP are mostly uniform. It also support by matrix of variance below.

	[,1]	[,2]	[,3]	[,4]	[,5]
[1,]	4.723429	4.0767856	2.4998563	1.0996097	3.1886500
[2,]	4.076786	3.5324632	2.1579671	0.9446716	2.7454545
[3,]	2.499856	2.1579671	1.3236941	0.5820443	1.6858593
[4,]	1.099610	0.9446716	0.5820443	0.2574489	0.7439571
[5,]	3.188650	2.7454545	1.6858593	0.7439571	2.1600273

Based on the value of variance in variance-covariance matrix, we can see the measure the variance of variable. Main diagonal of the matrix, the biggest is $var(X_1) = 4.723$ and the smallest is $var(X_4) = 0.247$. It tells that parent's income of awardee are really different and family dependent of each family of Bidikmisi Scholarship awardee are nearly uniform.
In general, each study programs at FMIPA having the same characteristic, except Physics and Statistics. The main characteristic for them is their parent's income less than UMR. But for Physics and Statistics, the working status of their parents who one/both of their parents not work is the main characteristic of awardee.

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THE ANALYSIS OF MATHEMATICS EDUCATION STUDENTS' ERRORSIN SOLVING LINEAR ALGEBRA PROBLEMS

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Abstract

Errors on solving linear algebra problems were still mostly done by mathematics education students. Whereas, linear algebra is one of the important materials as the basis of understanding other advanced mathematics materials. This study aims to find out the mistakes made by students in solving final exam problems of linear algebra, especially on the subject of vector space, also to identify the cause factors, so that it can be the basis in designing appropriate learning to overcome difficulties faced by students. The method used in this research is descriptive qualitative. The subject of this study is the second semester student of FKIP University of Bengkulu academic year 2016-2017. The research data was obtained from test result and interview. The result of the student test was analyzed and then described where the errors had done. Interviews conducted to get the deeper analysis about the errors made and about the factors causing those errors. Researchers found that the most common mistakes students made were in creating vectors in three dimensional spaces, and in defining the bases and dimensions of a vector space. This is because students had difficulty in determining the location of the coordinates of the vector's endpoints. The scale they used was not regular. Some students still had difficulty in using Elementary Row Operations, so students couldn't determine the basis and dimension of a vector space.

Keywords: *students' error, linear algebra, descriptive qualitative*

INTRODUCTION

Linear algebra is a basic course for a wide variety of disciplines, such as mathematics, physics, computer science, engineering and so on. (Mirko, 2003;Hogben, 2007).Then Egodawate (2011) said that a better understanding of algebra improves decision making capabilities in society. Through algebra, we can develop mathematical reasoning which is important and affecting decisions we make in our life such as personal finance, travel, cooking and real estate, etc. So,it is important to learn and understand linear algebra well, especially for mathematics education students.

The importance of learning linear algebra were followed by the importence of lecturers' knowing of the errors occurred in students learning. El-Khateeb (2016) stated Knowledge of the common errors made by students in teaching and learning mathematics is a matter of concern, especially in the first stage of a university education. His statement was supported by Veloo, Khrisnasamy, & Abdullah(2015). They said that by following the learning process we can catch' the loophole in the early stage of learning. Also Hidayati (2010 in Kumalasari, 2016) state that errors made by students show the difficulties they have in learning process.

Learning the students errors and the reason behind that errors help us to think what learning design we have to use for a better understanding in students' mind. El-

Khateeb (2016) also state that the teacher Knowledge and understanding of the common error of students help to develop strategies in teaching that address mathematical errors and misunderstandings, on the other hand, the learner benefit from the error, and through verification of assumptions and perceptions formed has started.

Edogawate (2011) said that an error is regarded as a mistake in the process of solving a mathematical problem algorithmically, procedurally or by any other method. Many university students also lack some basic understanding of algebra. Sometimes, they commit the same mistakes as their secondary school counterparts. They memorized only a few facts, formulas, and algorithms without understanding them conceptually, even though they could manipulate those limited number of facts in a correct or incorrect manner.

Mathematics education students in University of Bengkulu were still often commit errors in solving linear algebra problems. In learning process, and also in quiz and mid semester test, the errors often occur in their answer sheet. This condition made us as a lecturer want to find out the mistakes made by students in solving final exam problems of linear algebra, especially on the subject of vector space, also to identify the cause factors, so that it can be the basis in designing appropriate learning to overcome difficulties faced by students.

METHOD AND DESIGN

This research used descriptive qualitative method. The subjects were the second semester student of FKIP University of Bengkulu academic year 2016-2017. The data was obtained from test result and interview. The result of the student test was analyze and then described where the errors had done. Interviews were conduct to get the deeper analysis about the errors made and about the factors causing those errors.

FINDINGS AND DISCUSSION

This study was conduct by analyzing the results and the interview with some of the student representatives who made mistakes. The analysis of students' answers on the final exam shows that most errors were occur in the problem no.1, no.3, no.7 and no. 8. In problem no.1, 70% of students make errors in solving it. For the problem no.3, 72.5% of students doing errors. In the problem no.7, errors were occur in 67.5% of students answers, while in problem no.8, 37.5% of students make mistakes, and 40% of students didn't answer at all.

Problem no.1 asks students to describe the vector $\vec{u} = \langle 3,2,0 \rangle$ and $\vec{v} = \langle 2,3,4 \rangle$. The majority of students were wrong in determining the position of the point in three-dimensional space. A lack of understanding of the three-dimensional coordinate system was seen in student answers. Some students didn't use scale on the Cartesian axis correctly. In addition, for students who have been able to determine the position of the point, there were still did not draw the directional segment correctly. Figure 2 below is one example of an error made by M1 student.

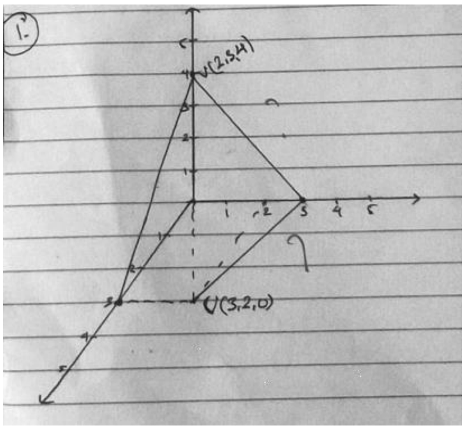

Figure 1. M1 answer of problem no.1

M1's Answer showed an error about the three-dimensional coordinate system. When drawing vector $\vec{u} = \langle 3,2,0 \rangle$, M1 can already determine the position $\langle 3,2,0 \rangle$ in Cartesian system, because z component is zero. But after determining the position, the student did not make the vector image properly. Vector u was only depicted with dashed lines. When drawing $\vec{v} = \langle 2,3,4 \rangle$, the student has difficulty determining the position $\langle 2,3,4 \rangle$, especially on the z component which value was 4 in the three-dimensional Cartesian system. It just drawn to $z$axis. Interview results showed that M1 is just familiar with two-dimensional coordinate system only, and difficult to understanding the position of the point on the three-dimensional system.

Other students (M3) showed such more errors. M3 did not even draw the x, y and z axes. M3 misinterpret the problem of drawing two vectors on a three-dimensional Cartesian system. M3 draws vector u and vector v as a two-dimensional axis, and created a line with less understanding of the coordinates. After the interview, M3 only focus on studying algebraic calculations only, not learn how to draw the graphics. Whereas, M3 had not really understood about the three-dimensional cartesius system. Answers M3 can be seen in figure 2.

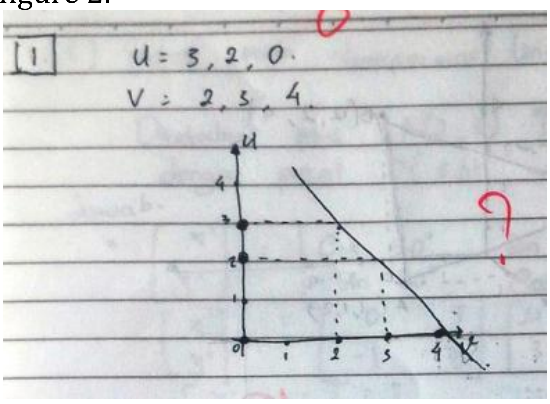

Figure 2. M3 answer of problem no.1

A similar error was found in Barniol & Zavala research (2014). The research showed that they have problems with the graphical interpretation of vectors. when they are explicitly asked to make a sketch or when the solution of the problem leads them to do so, the students have difficulties with the graphical interpretation of vectors.

The next most errors made by student were on problem no.3, where students are asked to add vector $u + v$ on problem no.1. One example of the error done by M2. He made a mistake in adding vector either graphically or algebraically. On completion, instead of summing the two vectors, M2 sums the x, y and$z$ components of each vector.

Graphically, M2 still made error started from making a Cartesian axis with no clear scale. M2 is also mistaken about the concept of adding two vectors graphically. M2 only follows the results of algebraic calculations had done, without understanding the concept of adding two vectors properly.

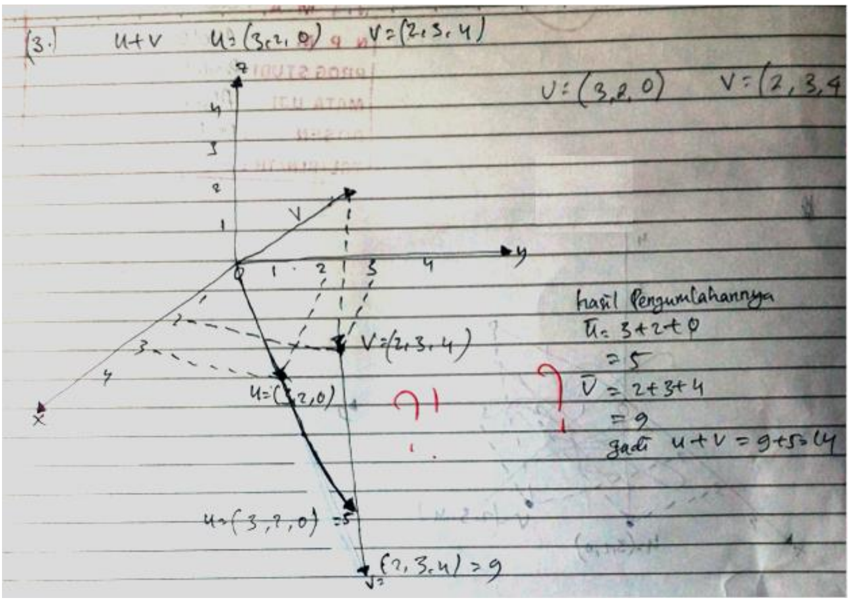

Figure 3. M2's answer of problem no.3

After being interviewed, M2 said that he did not read the book. He Just memorize d the formulas. When the exam, he forgot the formula, specifically how to add two vectors with different directions. So he solve the problem potluck. In addition there were certain psychological factors every M2 facing an exam. M2 used to read the whole questions, but when he saw a difficult problem, even if only one or two questions, M2 became nervous about the whole matter, so much matter was forgotten. This made he couldn't answer the whole test correctly.

Such errors were not only experienced by students of mathematics education, but also in physics students. Fauzi, Kawuri & Pratiwi (2017) also found that a tip-to-tail strategy add vectors graphically. The tip-to-tail "strategy of vector graphics when the magnitude and direction of vectors are different.

Problems no.7 asked to determine the basis for the SPL solution space by using Elementary Row Operations. An error example was done by M7 as seen in Figure 4.

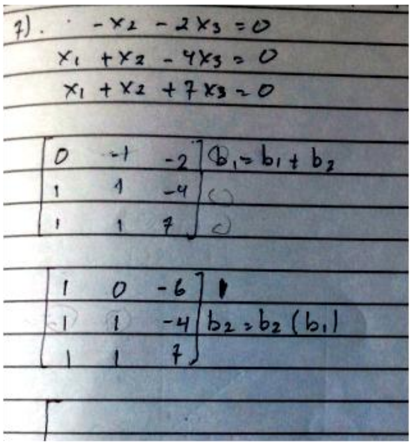

Figure 4. M7's answer of problem no.7

M7 False from the beginning change the linear equation into a matrix. M7 understood to make the head of a row a value of 1, but did not understand to make the element in the first row of the first column is zero and in the second column is 1 to obtain the identity matrix. If M7 continues the answer, then the second row will be [1 0 24]. M7 confused what next step should be done. Based on the results of this test, it appears that M7 does not understand the Elementary Row Operations steps as a whole. What matrices should be formed, and how to operate the matrix to obtain the required matrix. Therefore he coldn't determine the SPL solution space base on the problem. When interviewed, M7 admitted forgot about the Elementary Row Operations procedure due to the long and complicated process.

Nursuprianah & Solikhah, (2009) revealed one of the difficulties in the mathematics algebra learning process experienced by the student that is in completing elementary row operation using Gauss Jordan elimination. Similarly, Suastika, Johni H, & Utami (2015) in his study assume that compared to using the Cramer method, the row reduction method requires more diligence and more precision in solving a system of linear equations.

Problem no.8 asked students to make a problem and solve the rotation on the linear transformation. Compared with other questions, problem no.8 is a problem with the most number of students who did not answer at all. Based on interviews with some students, the majority explained that, it is difficult to make a problem compared to solving the problem. This is even more so when we do not really understand the material.

Students explained that in linear transformation materials, lectures were conducted independently, where students are given the task of group discussion for one type of transformation, then presented in the classroom accompanied by the lecturer. The majority of the students only focus on the subject matter which be they group discussion part, while for other linear transformation materials, they only listen to the presentation of their classmates. Students feel less understood if the explaination is from their own friend, they hope the material was explained by the lecturer.

From that facts on the process of solving problem no.8 it seems that the lack of student reguloation and independences in studying one of the subjects linear algebra. Though the basic material transformation they already get in high school. Fitria, Arnawa, Lufri (2014) said that the lack of students' understanding of the material and the accuracy of the students in working on the questions given because most students are very dependent on the lecturer's explanation when the reality in the field is the allocation of time provided by the university is limited considering also the amount of material that must be students mastered.

Some of the causes of mistakes made by mathematics education students in this study, are somewhat similar to those sources of students' difficulties in Linear Algebra which were synthesized by Dorier and Sierpinska (in Mirko, 2008) those are:

1) the axiomatic approach usually followed in teaching Linear Algebra which is perceived by students as superfluous and meaningless;
2) the coexistence of different languages, systems of representations, modes of description in Linear Algebra;
3) the need for developing theoretical thinking (as opposite to practical thinking) and cognitive flexibility to cope with the '"explosive compound" of languages, settings and systems of representation charactering Linear Algebra, and to develop theoretical thinking as opposite to practical thinking.

CONCLUSION

Researchers found that the most common mistakes students made were in creating vectors in three dimensional spaces, in adding two vectors, and in defining the bases and dimensions of a vector space. This is because students had difficulty in determining the location of the coordinates of the vector's endpoints. The scale they used was not regular. Some students still had difficulty in using Elementary Row Operations, so students couldn't determine the basis and dimension of a vector space.

Factors causing difficulties experienced by students were: students only focus on studying the calculation of algebra without understanding the interpretation geometrically. The habit of memorizing the formula, so got forgotten when the exam. In addition, the lack of diligence in solving of a problem, as well as the lack of student self-regulation are also the cause of student errors.

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LEARNING DEVICE DEVELOPMENTMATHEMATICS PROBLEM-BASED LEARNING MODELTO IMPROVE ABILITYMATHEMATICAL COMMUNICATION

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Abstract

Problem-based learning is a model of learning that presents students various forms of contextual problems in the learning process. The steps in problem-based learning are 1) Student orientation on the problem, 2) Organizing students to learn, 3) Guiding individual and group investigation, 4) Developing and presenting the work and 5) Analyzing and evaluating problem-solving process. Many of the mathematical skills that can be developed through problem-based learning include the ability of mathematical communication. Mathematical communication is the ability to use mathematical language to express ideas and arguments precisely, briefly and logically. This ability can be represented through the students' ability to describe problem situations and express problem solutions using images, explaining ideas, situations, and mathematical relationships in writing, using mathematical language appropriately. The ability of mathematical communication is very important for students. The more developing the language of mathematics students, the better the students in evaluating and arguing. The ability to evaluate and argue certainly provides students opportunities in understanding the various concepts / principles in mathematics. The success of learning mathematics should be coupled with the availability of learning tools. Therefore it is necessary to develop learning tools in accordance with the demands of the curriculum and also consider the needs of teachers and students so as to improve students' mathematical communication skills, especially in solving problems in everyday life. In this paper will be presented how the problem-based learning tools have the potential to improve students' mathematical communication skills.

Keywords: *learning tool, problem based learning, mathematical communication*

INTRODUCTION

Education is a thing that can not be separated from human life and lasts for life. Great nation must have a quality education. Quality education is closely related to quality human resources. To create qualified human resources, we need high quality learning process.

The process of learning in schools occurs in various fields of study, one of which is the subject of mathematics. Mathematics learning aims to learners have the ability to communicate ideas with images or other media to clarify the situation or problem and have an attitude appreciate the usefulness of mathematics in life. Therefore, to achieve the purpose of learning mathematics, one aspect that must be mastered by students is the ability of mathematical communication.

Lia (2013) suggests that communication is a process of transferring ideas from the source to the recipient with the intention of changing his behavior. According Yonandi (2011), Mathematical communication is a skill to convey ideas or ideas in everyday language or in the language of mathematical symbols. According to Darmawan (2010) The benefits of a communication in learning mathematics can encourage students to learn new concepts in mathematics, because in learning mathematics students can draw, provide explanations using writing, and use the symbols of mathematics. Furthermore, Fachrurazi (2011), states that students' mathematical communication skills are divided into three groups namely drawing, math expression and writing. By developing mathematical communication skills, students are expected to understand the concepts of what they learn and use to solve problems in their lives.

Esther (2012) states in fact the purpose of learning mathematics in Indonesia has not been achieved properly. This is reflected in the results of The Trend International Mathematics and Science Study (TIMSS) in 2011, Indonesia ranked 38th with a score of 386 from 42 countries whose students are tested with the average achievement of achievement used TIMSS is 500, this score Down 11 points from the 2007 assessment. Similarly, OECD (2013) discloses the results of the PESA survey in 2013, Indonesia ranks only 64 out of 65 participants.

Sri, Wardhani (2011) stated that the low TIMSS and PISA results are of course caused by many factors. One of the contributing factors is that Indonesian students have not been able to solve problems with characteristics such as those in TIMMS and PISA whose substance is contextual, demanding reasoning, creativity and argumentation in completion. This shows that the mathematical communication ability of Indonesian students is still low. This is because students are only accustomed to working on routine questions or problems that have been commonly given teachers. When faced with a problem that demands the ability to think mathematically and change the matter into the form of mathematical models they are difficult to do. Based on classroom observation, it is known that in the learning process it is seen that the students only dare to express their answer to the next friend. Students have not dared to express the answer of the questions given by the teacher.

One of the causes of poor students' mathematical communication skills is the way teachers teach less accurately. The majority of the learning that is commonly applied so far is monotonic and the learning activities are still dominated by teachers. Less students are given the opportunity to express their own opinions. This cause the potentials in the student can not be seen maximally and make students easy to give up so easily. This indicates that there needs to be an innovative applied learning model that can explore students' mathematical communication skills.

According Tatang, Herman (2007) PBM is one alternative to improve students' mathematical communication skills. The teaching and learning process begins with giving a contextual or meaningful problem or situation. Students are then invited to understand the problem and start thinking how to solve the problem and train sensitivity to the problem.

Furthermore, the process guides individual and group investigations that allow students to exchange answers and produce a flexible solution of existing problems and ideas conveyed from themselves. By conducting group discussions, each student gained experience with others during the lesson. It can improve students' mathematical communication skills. Students are trained to convey opinions within their group, so that their verbal skills also increase. Then some students presented the results of the discussion in detail and fluent in front of his friends so that found a right deal.

Based on the above background, then the issues studied in this journal are 1) what is the masala based learning ?; 2) what is the mathematical communication ?; 3) how the learning tool of problem-based learning model has the potential to improve students' mathematical communication ability. In accordance with the formulation of the above problem, then the purpose of this journal is 1) to know what is problem-based learning; 2) to know what is the ability of mathematical communication; 3) to find out how problem-based learning tools have the potential to improve students' mathematical communication skills. Benefits of this journal is expected after reading this journal readers can find out how the problem-based learning tools can improve students' mathematical comunication ability and can as one reference learning model that can dipraktekan to students to dig more leverage ability owned by students.

DISCUSSION

1. Problem Based Learning Model (PBM)

According to Sudarman (2007) Problem-based learning is a learning model that uses contextual problems as a context for students to learn about critical thinking and problem-solving skills, and to acquire essential knowledge and concepts from subject matter.

Rusman stated that problem based learning is based on constructivism learning theory with characteristics: (1) Understanding is gained from interaction with problem scenario and learning environment; (2) The struggle with problems and problem discovery processes creates cognitive dissonance that stimulates learning; (3) Knowledge takes place through the process of collaboration of social negotiation and evaluation of the existence of the point of view.

According to Made, Wena (2011) Problem-based learning, students are faced with practical problems as a foothold in learning or in other words students learn through the problems. Furthermore According to Tatang Herman (2007) Students are required to solve problems that contain mathematical concepts with the knowledge and ability possessed.

The stages of implementation of problem-based learning by Darmawan (2010) are presented in Table 1.

Table 1. Phases of Problem-Based Learning Model

Phase	Indicator	Master's Behavior
1	Student orientation on the problem	The teacher explains the learning objectives, explains the necessary logistics and motivates the students to engage in problem-solving activities
2	Organize students to learn	Teachers help students define and organize learning tasks related to the problem......
3	Guiding individual and group investigations	Teachers encourage students to gather appropriate information, carry out experiments to get explanations and problem solving

4	Develop and present the work	Teachers assist students in planning and preparing work accordingly such as reports and helping them to share tasks with their friends
5	Analyze and evaluate the problem-solving process	Help students reflect on or evaluate their investigations and the processes they use

According to Rusman (2011) The role of a teacher in problem-based learning, among others: (1) Designing and using the existing problems in the real world, so that students can master the learning outcomes; (2) Become a student trainer in problem-solving process, self-direction and peer learning; (3) Facilitating the PBM process that is changing the way of thinking, developing inquiri skills and using cooperative learning; (4) Train students on problem-solving strategies, critical thinking and systematic thinking; (5) Being an intermediary of the process of using information.

Problem-based learning has 5 characteristics, among others: Through collaborative activities, students are positioned as problem solvers, encouraging students to be able to find problems and elaborate by proposing allegations and planning solutions, students are facilitated in order to be able to exploit alternative solutions and their implications and collect and distribute Information, students are trained to skillfully present findings, as well as familiarize students to reflect on the effectiveness of their way of thinking and problem solving.

According to Prametasari (2012) Problem-based learning model has several advantages, including: (1) Students better understand the concepts taught because students themselves who find the concept; (2) Students are actively involved in problem-solving processes that require higher student thinking skills; (3) Knowledge is embedded based on the students' schemata so that students are more meaningful; (4) students can feel the benefits of learning because the problems solved directly related to real life, this can increase students' motivation and interest in the material being studied; (5) Making students more self-reliant capable of giving aspirations and accepting the opinions of others, inculcating positive social attitudes among students; (6) Conditioning students in learning groups that interact with each other so that the achievement of student learning completeness can be expected.

The problem in PBM is contextual and engaging, so it stimulates students to ask questions from different perspectives. Questions and discussions in the PMB test the accuracy of the solution and reflect on the problem solving. PBM requires that students actively solve problems they are facing by communicating with friends, books, and teachers.

2. The ability of mathematical communication

According to Ali (2009) "Communication is the use of symbols such as words, pictures, figures, and others in conveying information, ideas, emotions, skills, etc.". Mathematics is a science that the terms of symbols, terms, and images that demand good communication skills in delivery. Therefore, students must have good mathematical communication skills so that learning objectives can be achieved. This causes the ability of mathematical communication becomes something that is important to be explored by a teacher in learning mathematics.

Husna (2013) states "There are two reasons for focusing on mathematical communication that is, (1) Mathematics is an essential language for mathematics itself; (2) learning and teaching mathematics is a social activity that requires communication skills so as to solve problems well ". Furthermore, Lia (2013) argues that "The benefits of a communication in learning mathematics can encourage students to learn new concepts in mathematics, because in learning mathematics students can use tools or objects, drawing, giving explanations or considerations, using diagrams, writing, and using Mathematical symbol ".

Disclosure of the importance of communication in learning mathematics, can be found also in various textbooks of mathematics in the United States. For example, in the book Connected Mathematics it is written that The Overarching of Goal of Connected Mathematics is "All students should be able to reason and communicate proficiently in mathematics" (Lappan, 2002). While in the book Mathematics: Applications and Connections mentioned one of the goals to be achieved is to provide the widest opportunity to the students to develop and integrate communication skills through modeling, speaking, writing, talking, drawing, and presenting what has been learned (Collins, Et al., 1995).

The "National 2006" curriculum based on the level of educational unit for elementary, junior and senior high schools also promotes mathematical communication skills as one of the basic skills students need to have.

According to Baroody (1993), on learning mathematics with traditional approach, communication (oral) students are still very limited only on short verbal answers to various questions posed by teachers. Even according to Cai (1996) 'it is so rare for students to provide explanation in mathematics class, so strage to talk about mathematics, and so surprising to justify answer ".

Mathematical communication needs to be the focus of attention in learning mathematics, because through communication, students can organize and consolidate their mathematical thinking (NCTM, 2000a), and students can convey mathematical ideas (NCTM, 2000b). In addition, according to Atkins (1999), mathematical conversational communication is a tool for measuring growth in understanding,

Awareness of the importance of paying attention to students' ability to communicate using mathematics learned in schools needs to be grown, because one of the functions of mathematics lessons is as a way of communicating ideas in a practical, systematic, and efficient way. Or in Baroody (1993): "an invaluable tool for communicating a variety of ideas clearly, precisely, and succintly."

The ability of mathematical communication includes 2 forms namely written and oral. However, what is often discussed in the research - research is the ability of written communication that includes the ability to draw (drawing), writing (written texts), and mathematical expression (mathematical expression) with the following indicators according to Latifah (2011):

A. Describe the problem situation and state the problem solution using the image.
B. Explain ideas, situations, and mathematical relations in writing.
C. Use mathematical language appropriately

Student's mathematical communication ability according to Darmawan (2010) can be seen from students ability in:

1) Write mathematically (written text). In this ability, students are required to be able to write an explanation of the answer to the problem mathematically, reasonable, clear and arranged logically and systematically;
2) Drawing mathematically (drawing). In this ability, students are required to be able to paint pictures, diagrams and tables completely and correctly;
3) Mathematical expression (mathematical expression). In this ability, students are expected to model mathematical problems correctly or express mathematical concepts by declaring daily events in language or mathematical symbols correctly, then performing calculations or getting a complete and correct solution.

According to Cobb in (Sandra, 1999), by communicating students' knowledge, renegotiation can occur among students, teachers only act as "filters". Cai and Patricia (2000) argue that teachers can accelerate the improvement of mathematical communication and students' reasoning by providing mathematical tasks in various variations. According to Susan (1996), mathematical communication will play an effective role when teachers also condition students to listen actively (listen actively) as well as they communicate.

Findings relating to problem-based learning and mathematical communication skills

Based on Triana (2014), it is found that learning tools with problem-based learning model can improve students' mathematical communication ability. This is because the phase of this problem-based learning model requires many people to exchange ideas so that communication often occurs and train their communication skills. Starting from the student's orientation to the problem, organizing the students to learn, guiding individual and group investigations, developing and presenting the work and analyzing and evaluating the problem-solving process. While the results of research by Sri Ismaya (2016) obtained that the learning tool of mathematics by using Problem Based Learning approach can improve students' mathematical communication ability. The increase is mentioned because the lesson is more emphasized on the activity of the students, by conducting group discussions, giving each other opinion to determine the solution of the given problem, thus making the students trained in communicating mathematical ideas and thoughts that will ultimately be able to improve student communication in learning mathematics.

The first step is the student's orientation to the problem. In this step, the teacher explains the learning objectives and explains the things that are needed during the lesson and motivates the students to engage in problem-solving activities with examples of problem situations in everyday life related to learning materials. Motivation and learning objectives described by the teacher will make students have hope or goals to be achieved students after following the lesson.

The next step is the teacher organizes the students to learn and then guides individual and group investigations. In this step the teacher divides the students into heterogeneous groups and students are given Student Worksheets (LKDP). Then, the students discuss with the group members to solve the problems that exist in the LKPD. In the activity of the discussion, students are required to be able to communicate their ideas into the mathematical symbols and illustrations of the image well and with a logical explanation, it will certainly develop students' mathematical communication skills. In addition, the interaction of students in a group of friends will form a view how he plays in the group or make students more familiar with how the ability that he has compared his friends. Some students have a positive view of their ability and some have a negative view of the ability that he has. But the negative view will turn positive when students with their group feel they have been able to solve the problem well. Based on the description, then students' mathematical communication ability will increase after students get problem based learning.

The next step is to develop and present the work. In this phase, some groups present the results of the discussion in front of the classroom with guidance from teachers and other groups responding. Through this learning process, students will be actively involved and given the opportunity to express their ideas and opinions. In this activity will develop students' mathematical communication skills.

The last step is to analyze and evaluate the problem-solving process. In this step, the teacher helps students to reflect or evaluate and clarify the results of the discussion then the teacher with the students concludes the material that has been studied.

Correspondingly, based on the results of research Fachrurazi (2011) Problem-based learning is effective to improve students' mathematical communication skills. This is because in the learning process based on the focus of learning activities are fully located in the students is thinking find solutions and understand the mathematical concepts contained in the problem. In such situations students' mathematical communication skills are maximally explored, as students will utilize their cognitive abilities in their search for solutions and confirmation of the knowledge they have in mind.

CONCLUSIONS AND SUGGESTIONS

CONCLUDE

1. The ability of mathematical communication is one of the heart in learning, so it needs to develop in the activity of learning mathematics. Mathematical communication skills is one of the basic capabilities that are needed to increase as more basic abilities such as reasoning ability, the ability of mathematical understanding, problem solving skills, mathematical communication skills and connections, as well as representations of mathematical ability.
2. Problem-based learning tools is one alternative that can improve students' mathematical communication skills. This is because each step in the learning can support the development of students' mathematical communication skills.

SUGGESTION

Advice can be given to educators in an effort to improve communication kemampun mathematically, it is recommended to use a learning device with a problem-based learning model in math learning in the classroom.

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THE INFLUENCE OF LEARNING MODELS PROBLEM BASED LEARNING TO INCREASE UNDERSTANDING CAPABILITIES CONCEPT AND RESOLVE MATHEMATICAL PROBLEMS ON THE PARTICIPANTS

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Abstract

This study aims to see the effect of learning models to improve the ability of understanding the concept and problem solving skills of mathematics learners. The lack of ability to comprehend the concept and problem solving ability caused by the students having difficulties in learning mathematics such as learners less able to dig their own information in learning because they are accustomed to the explanation of teachers in front of the class, learners are less able to understand the mathematics material that is learned, the level of seriousness of the learners In reviewing the subject matter is still relatively low, learners less involved in solving problems. As a result, the potential that exists in students in learning and mastering the concept of mathematics can not develop maximally so when given the problem of problem-solving ability is not able to solve it The solution is used as an alternative in improving the problem solving ability of mathematical learners through problem-based learning model. Problem-based learning is a learning that confronts learners in real situations by linking every learning material in everyday life and learning begins with a real experience-oriented experience by the learners themselves. The research method used is research literature study that is by collecting various information about problem-based learning model. After conducting a literature study by citing data about problem-based learning mattles from various sources so it is suspected that the problem learning model can improve the ability to understand the concept and solve the mathematical problem of the learner

Keywords: *Problem Based Learning, Ability to Understand Concepts, Problem Solving Abilities*

PRELIMINARY

One area of study that supports the development of science and technology is mathematics. Math lessons need to be given to all learners to equip learners with logical, analytical, systematic, critical, and creative thinking skills, as well as the ability to work together. These competencies are necessary so that learners can have the ability to acquire, manage, and utilize information to survive in an ever-changing, uncertain, and competitive state.

The demand for mathematics has become the responsibility of the school which is the educational environment. Mathematics is one of the conditional subjects that every student should learn. Basically the purpose of learning mathematics in school is to prepare students to be competent in understanding the concepts of mathematics.

Competence and proficiency in understanding mathematics is expected to be achieved through mathematics learning. Depdiknas (2006) through Permendiknas No. 22 on the content standard has been stated that the purpose of learning mathematics in SD / MI, SMP / MTs, SMA / MA, and SMK / MAK is for learners (1) Understanding the concept of mathematics, explaining the interconnection between concepts and apply the concept or algorithm, flexible, accurate, efficient, and precise in problem solving. (2) Communicating ideas with symbols, tables, diagrams, or other media to clarify the state of a problem. (3) Have an appreciation of the usefulness of mathematics in life, which has a curiosity, attention and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving

The low ability of problem solving of students 'mathematical problem is caused by several factors, one of them is the less innovative teacher in choosing the model, the method, the approach, the strategy and the learning technique which can increase the students' desire in solving the math problem. As revealed by Eva (2016), the main factor causing low ability of problem solving of student math, that is learning which has been done so far has not been able to develop problem solving ability of student

One-way teaching that uses only lecture methods so as to create an atmosphere of learning is dominated by teachers. Although in this learning learners can listen to statements that are pleased with the concept of mathematics, but there is an impression that the active is the teacher itself, while the students only as a listener explanation of the teacher while recording the information provided

The above learning resulted in learners tend to memorize the formulas and stages of problem solving from understanding the concept. So that the potential that is in the learners in learning and mastering the concept of mathematics can not develop maximally. While the ability to understand the concept is needed so that learners are accustomed to understand and use reasoning power to think so that it can be useful in solving problems. To improve the ability of concept comprehension and problem solving is not an easy task, but it is not impossible to realize. It all depends on the design and the way of learning that teachers apply in the learning of mathematics.

One of the aspects contained in the learning of mathematics is the concept. Dahar (1988: 95) mentions, "If likened, the concepts are the stones of development in thinking". It would be very difficult for students to get to a higher learning process if they had not understood the concept. Therefore, the ability to comprehend mathematical concepts is one of the important goals in learning mathematics. As a facilitator in learning, teachers should have the view that materials taught to students are not just memorizing, but more than that, understanding the concepts given. By understanding, students can better understand the concept of the subject matter itself, not just memorized

Understanding mathematical concepts is important for learning mathematics meaningfully, of course, teachers expect that students' understanding is not limited to understanding but can connect to other concepts. This is the most important part of mathematics learning as Zulkardi states (2003: 7) that "mathematics subjects emphasize the concept". This means that in learning mathematics learners must understand the concept of mathematics in advance in order to solve the problems and able to apply the learning in the real world and able to develop other capabilities that became the goal of learning mathematics. Therefore, students who have good conceptual understanding skills will contribute greatly in solving and solving mathematical problems

Seeing so complex problems in the learning of mathematics, it is necessary for the efforts of teachers to overcome it. For that teachers need to design a learning that creates conditions to allow the process of good interaction with learners, so that they can perform various learning activities effectively. So Relate to the above problems of learning it is necessary solution to solve the problem by applying a model of learning that is able to create a variety of learning atmosphere, centered on students and able to improve the ability of understanding the concept and problem solving in learning mathematics. Learning in question is a problem-based learning model.

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. These data sources contain: Ability to understand concepts, problem-solving skills and School-Based Learning. These sources are obtained from journals, books, research report articles and internet sites

RESULTS AND DISCUSSION

According to Joyce & Weil the learning model is a plan or pattern that can be used to shape the curriculum (long-term learning plan), designing learning materials, and guiding classroom or other learning (Rusman, 2012: 133). Furthermore, according to Muslimin I (Boud and Felleti, 2000: 7), problem-based learning is an approach to teaching students to develop thinking skills and problem-solving skills, studying the role of adult auntentik and becoming an independent learner. Problem-based learning is not designed to help teachers provide as much information to students as possible, but problem-based learning is developed for intellectual skills, learning various adult roles through their involvement in real-life experiences and becoming self-directed learning.

In agreement with the above opinion, Moffit (Depdiknas, 2002: 12) suggests that problem-based learning is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills and to acquire knowledge and concepts that are essentially subject matter. Then, according to Rudi Hartono (Nurdin, S. 2016: 221) that problem-based learning is a learning process that exposes students to a problem before starting the learning process. Students are faced with a real problem that drives them to research, decipher and seek solutions.

Based on some of the experts above, it can be concluded that problem-based learning is a learning that confronts students in real-world situations by linking each learning material in everyday life and learning begins with a real experience-oriented orientation by the students themselves. Thus, through the implementation of this problem-based learning model will create an active learning atmosphere because this learning will trigger students' curiosity about the material being studied because it is related in their own life.

Ibrahim and Nur (2000: 13) and Ismail (2000: 1) suggest that the steps (syntax) of problem-based learning, as follows.

Table 1 Problem-Based Learning Steps

Phase	**Indicator**	**Teacher Behavior**
1	Student orientation on the problem	Explain the learning objectives, explain the logistics required, propose phenomena or demonstrations or stories to raise issues, motivate students to engage in problem solving.
2	Organize students to learn	Helps students to define and organize learning tasks related to the problem.
3	Guiding individual / group experiences	Encourage students to gather appropriate information, carry out experiments, to get explanations and troubleshooting.
4	Develop and present the work	Assist students in planning and preparing appropriate works such as reports, videos, and models and helping them to share tasks with their friends.
5	Analyze and evaluate the problem-solving process	Helps students to reflect on or evaluate their investigations and the processes they use.

Meanwhile, according to Kemendikbud in the curriculum socialization materials of 2013 the role of teachers, and problems in problem-based learning can be described as follows:

Table 2 The Role of Teachers, Students and Problem-Based Problems of Learning

Teachers as trainers	Student as *problem solver*	The problem as an initial challenge and motivation
1. *Asking about thinking* (bertanya tentang pemikiran) 2. Monitoring Learning 3. *Probbing* (menantang siswa untuk berpikir) 4. Keep students engaged 5. Organize group dynamics 6. Keeping the process going	1. Active participants 2. Engage directly in learning 3. Building learning	1. Interesting to solve 2. Provide needs that have to do with the lossons learned

Based on the above description, the following is discussed how the problem-based learning model can improve the ability to understand the concept and solving the problems of learners. The first stage of orienting learners on the issue, this stage is very important where the teacher should explain in detail what should be done learners and also by teachers, and explained how the teacher will evaluate the learning process. It is very important to provide motivation so that learners can understand in the learning done. The second stage of organizing learners to learn, problem solving requires cooperation and sharing among members. According to Karatas and Adnan (2013) with groups of learners can share and compare their thoughts with peers in discussing different ideas. Therefore teachers can start learning activities by forming groups of learners where each group will choose and solve different problems. Teachers are very important to monitor and evaluate the work of each group to maintain group performance and dynamics during learning. Once the learner is oriented to a problem and has formed a further learning group teachers and learners establish specific subtopics, investigative tasks, and schedules. The main challenge for teachers at this stage is to ensure that all learners are actively involved in a number of investigative activities and the results of this investigation can result in a resolution to the problem.

In the third stage it helps to develop and present the work, although each problem situation requires different investigation techniques, but generally involves identical characters, ie data collection and experimentation, hypothesizing and explaining and providing solutions. According Ozsoy (2015) understanding of the problem is the establishment of a mathematical relationship between what is given pa funds needed. After learners collect enough data and provide problems about the phenomena they investigate, they then begin to offer explanations in the form of hypotheses, explanations and solutions. During teaching at this stage, the teacher encourages the learner to convey all his ideas and fully accept the idea. Teachers should also ask questions that make learners think about the feasibility of hypotheses and solutions they make as well as about the quality of the information gathered.

The fourth stage develops and presents the work, at this stage of investigation followed by creating artifacts (exhibitions) and exhibitions. Artifacts are more than a written report, but can be a video tape (showing the problem situation and proposed solutions), models (physical manifestations of problem situations and solutions), computer programs, and multimedia presentations. The next step is to showcase the results of his work and teacher ebrperan as organizer of the exhibition. It would be better if in this exhibition involving other students, teachers, parents, and others who can be an assessor or provide feedback. The fifth stage analyzes and evaluates the problem-solving process. This phase is the final stage, intended to help learners analyze and evaluate their own processes and the inquiry and intellectual skills they use. During this stage the teacher asks the learners to reconstruct the thoughts and activities that have been done during the learning process

In terms of learning is essentially learners directed in meaningful learning where the subject matter taught is connected in the real life of learners or based on the experience of the learners themselves. So this kind of presentation makes it easier for learners to understand and understand the concept of mathematics as it is lifted from real life. Then on this learning learners directed to solve the problems of mathematics with activities to find and analyze every problem of mathematics and in learning learners are required to be actively involved in learning. Based on the given problem, learners will put forward the solution of each group task. This will lead to the development of conceptual comprehension and problem-solving skills, as learners can relate the problems given to the real world.

This is also supported by the results of research that has been done by Dinandar (2014) in vocational students concluded that the ability to think critically mathematically taught by using the model of Problem Based Learning is higher than the students' mathematical critical thinking skills are taught using conventional learning model. So it can be interpreted that there is a good influence on the application of Problem-Based Learning model to students' mathematical critical thinking skills. And research Ageng Prakoso Rubi (2012) research results show that with the application of problem-based learning to improve activity and learning achievement in the eyes of PDIL training in SMK Muhammadiyah 3 Yogyakarta.

CONCLUSIONS AND RECOMMENDATIONS

Problem-based learning model will have a positive effect on the ability of concept comprehension and mathematical problem solving. This is because the stages in the problem-based learning model, with this stage directing teachers to obtain the maximum, the stages are: orientate learners to the problem, organize learners to learn, guiding individual or group experience, develop and present the work As well as analyzing and evaluating the problem-solving process.

Based on literature studies that have been done then the authors suggest:

1. For teachers or educators who want to improve the ability to understand the concept and problem-solving skills of participants dididk then the problem-based learning mazel is one alternative that can be applied to learners.
2. For the next author who wants to write about the problem-based learning model is suggested to study how to improve students' mathematical thinking ability by using problem-based learning model

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THE EFFECT OF 7E LEARNING CYCLEAGAINST STUDENT'S MATHEMATICAL CONCEPT UNDERSTANDINGOF CLASS X SMA NEGERI 12 PADANG

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Abstract

Student's mathematical concept understanding is one of the learning goals that want to be developed optimally on students. Because the mathematical concepts are irrelated, so to learn it must be coherent and sustainable. Based on the observation that has been done in SMA Negeri 12 Padang, it was found that student's mathematical concept understanding not develop optimally. Student are less involved in the learning process and tend to like to discuss with other students about the material that has not been understood. The solution for this problem is applying learning cycle 7E model. This research aim to see student's mathematical concept understanding who attend learning cycle 7E model better than student's mathematical concept understanding who attend conventional learning. This research was quasy experiment using Static Group Design. The population of this research is the students of class X SMA Negeri 12 Padang which amounted to 346 students. Sampling was done by random sampling technique. The instrument used is the final test of essays to see student's mathematical concepts. The test data were analyzed using the Mann-Whitney test. The result of this research showed that student's mathematical concept understanding who attend learning cycle 7E model is better than student's mathematical concept understanding who attend conventional learning with a significance level of 0.05.

Keywords: *learning cycle 7E, learning mathematics, mathematical concept understanding.*

INTRODUCTION

Mathematics is one of the lessons taught from elementary to college level. until now there are still assuming mathematics is a difficult subject, boring, even scary. The cause of the assumption is because mathematics has abstract properties so to learn it requires a good understanding of the concept.

Understanding is the ability of a person to understand or understand something after something is known and remembered (Sudijono, 2011: 50). A learner is said to understand something if he could provide an explanation or give a more detailed description about it using his own words. In learning mathematics, understanding the concept is very important for students because the mathematical concepts that one with the other are related so to study it must be coherent and sustainable. One of the goals of learning mathematics in secondary education is that learners can understand the concept of mathematics, is a competence in explaining interconnectedness between concepts and using concepts and algorithms, flexibly, accurately, efficiently and appropriately in problem solving. Learning mathematics will not work if students do not understand the concept from the beginning. In accordance with the essence of mathematics itself that the concept of mathematics arranged in a hierarchical, structured, logical, and systematic from the concept of a simple to the most complex concept (Suherman, 2003: 22).

Based on observations made in class X SMA Negeri 12 Padang, on 24, 25, 26, and August 28, 2015 found that the concept of student understanding is low, it is seen from the question and answer activities conducted between teachers and students, the basic questions that needed answers to understand the concept of students, but students still find it difficult to explain in their own words. Some students have tried to answer correctly, but most of the answers given are still wrong. However, at the time the learning process takes place students tend to be passive and only accept the material given the teacher without being actively involved in the learning so that in doing the exercise many difficulties experienced by students. But students do not appear to ask the teacher but are more likely to ask their friends about the incomprehension. This shows the students prefer to discuss in groups. This is also evident from the results of mid semester I exam that has been done. Errors that many students experience is on the matter no.1 and no.4, as follows:

1. Simplify and change in the form of positive rank.

$$\left(\frac{4x^{-3}y^{5}}{12x^{4}y^{3}}\right)^{-2}$$

4. If ${}^{5}\log 3 = a$ and ${}^{3}\log 2 = b$. Determine the value of ${}^{4}\log 15$!

The problem represents several indicators of conceptualization, namely: re-presenting a concept (question no.1) and presenting concepts in various forms of mathematical representation and using, utilizing and selecting a particular procedure or operation (question no.4). Here is one of the student answers.

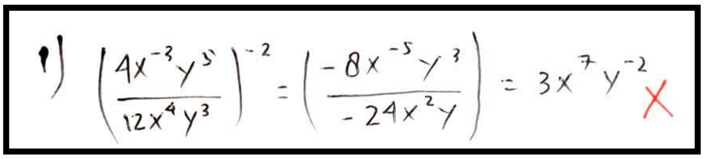

Figure 1. One of the student's answers

Figure 1 is an incorrect student answer to question number 1. From the picture, the student can not reiterate the concept of exponent (rank), which is about the properties of integer integers and does not understand the concept of converting the negative rank into positive rank. In general, students who solve the problem experience the same error as in Figure 1, only a few students who can complete correctly and correctly that is less than 30%.

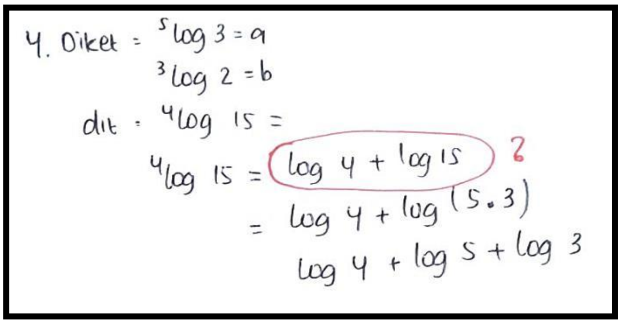

Figure 2. One of the student's answers

Figure 2 represents the wrong student's answer for item number 4. From the picture it can be seen that the students still do not understand the concept of logarithm because it has not been able to present the concept in various forms of mathematical representation correctly and still can not understand and choose the nature of logarithm that can be used to solve the problem . Students have not been able to identify the properties of a concept so that the final answer obtained is also wrong. It should be a step that students can use to solve the problem by changing the form of $^4\log 15$ according to the logarithmic properties and known from the problem.

Similarly to question number 1, from question number 4 also only some students who can give the correct answer that is about 20%. From the description shows that the students still do not understand the concept of rank numbers and logarithms so that they can not answer the problem by using the appropriate procedure. The number of students whose value reaches the Minimum Completeness Criteria established by the school, which is 80, is generally still less than 30%. Based on the data of mid semester I mathematics lesson year 2015/2016 obtained from mathematics teacher class X SMA Negeri 12 Padang, from 11 class X that exist, there is only one class with KKM percentage level exceed 25% that is equal to 25,81%. While the other classes do not reach 10% of students who complete. The completeness is still far from the expected classical thoroughness, which is 85% (Depdikbud in Trianto, 2012: 241). The low learning outcomes of students because the student's mathematical concept understanding is low.

The problem is caused by the lack of confidence of students in exposing their opinions or ideas in solving a problem given by the teacher and not actively construct their own concept of the material being studied. Learning models used in mathematics learning tend to be conventional. Students only accept what is given by the teacher or receive the result of a friend's work so they do not understand the concept and are more likely to memorize the mathematical formula. As a result, the expected mathematical capabilities appear not well developed. The low level of mathematical concepts leads to other learning goals that will be difficult to achieve and students' mathematics learning outcomes will be low as well.

Therefore, it is necessary to apply a learning model that supports students to develop their conceptual understanding, and in accordance with the characteristics of students who like to discuss. One of the learning model that seeks students to be active in building and understanding the subject matter and in accordance with the characteristics of students is the learning model of learning cycle 7E.

Learning cycle model is one of the learning model with constructivist approach (Wena, 2012: 170). Students try to construct their own thoughts so that students' understanding of the taught concept is obtained by their own cognitive thinking. Learning is done not only in the direction (teacher to student), but the active role of the students takes precedence so that will happen the learning process from various direction. With this model students can also have the confidence to appear in front of the class explaining the material being studied and expose their opinions or ideas in solving problems and changing negative student habits as learning takes place into positive and useful activities.

Learning cycle begins by testing three phases: (1) exploration, (2) concept development, and (3) discovery (Marek, 2008: 63). Three cycles are developed into five stages consisting of the stage of engagement, exploration, explanation, elaboration, and evaluation or referred to as Learning Cycle 5E (Wena, 2012: 171) . The proposed 7E model extends the engagement stage into two components: elicit and engagement. Similarly, in the elaborate and evaluate stage expanded into three stages of elaborate, evaluate, and extend. The transition from model 5E to 7E model can be seen in Figure 3.

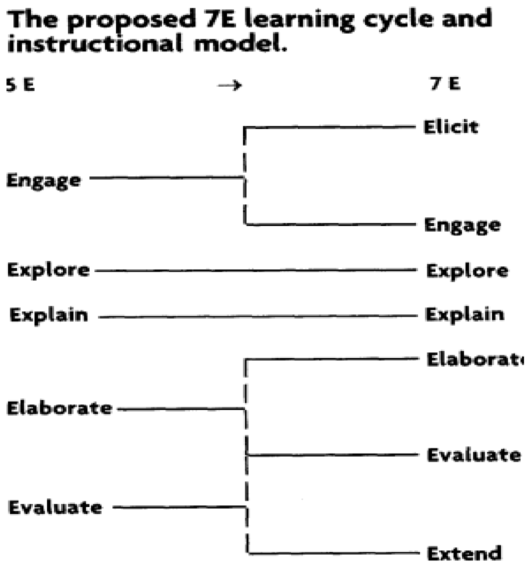

Figure 3. Change Learning Cycle 5E to Learning Cycle 7E
Source: Expanding the 5E Model (Eisenkraft, 2003: 57)

The change is not to add complexity, but to ensure that teachers do not remove the essential elements to learn from their lessons, while with false assumptions they meet the learning cycle requirements (Eisenkraft, 2003: 57). The 7E learning cycle learning model consists of 7 stages, which is to elicit an early understanding of the students (elicit), engagement, exploration, explanation, elaboration, evaluation, and extending. In the elicit stage the teacher gives apperception by asking questions related to the material to be conveyed, to find out where the initial knowledge of the students on the subject matter; Stage engagement, teachers align students' perceptions with the concepts brought by the teacher. The teacher's activity in this phase is to provide a material explanation to clarify the perception of the wrong student. Teacher gives an explanation but not fully discussed. Teachers invite students' knowledge by showing interesting activities so that students have a curiosity and are interested in learning the material further (Sumiyati et al, 2016: 43-44). The exploration stage of the students is given the opportunity to discover and prove the concept of the material in a new situation that will provide new experiences so that new questions and problems arise which lead to debate and analysis of the reasons for the idea that will lead students to acceptance or rejection of the idea (Yuliati in Pebriana, 2014: 3).

Student exploration results are presented in front of other friends, which is an explanation stage. Teachers encourage students to explain a concept with their own sentences or thoughts, ask for evidence and clarify the students' explanations, and critically listen to each other's explanations between students or teachers. Teachers as facilitators to guide the discussion, while students are managing the data, looking for patterns, making comparisons, and identifying problems after students declare conceptual understanding, teachers or students can introduce related scientific terms. Then, students are asked to find many solutions and ideas, not just one "right" answer. They may repeat the activity or they may wonder about some component or application of the activity, thus starting the cycle again as they explore new ideas (Mecit, 2006: 4). Furthermore, in the elaboration stage, students apply the concepts and skills that have been learned in new situations in the form of tasks assigned by the teacher. From several series of stages, teachers evaluate the understanding of concepts received by students. At this stage can be used a variety of assessment strategies both formally and informally teachers, assess how the development of knowledge that has been accepted students. After the evaluation, in the final stage of the extend stage, students develop elaborate results and submit it again required to think, seek, find, and explain examples of application of new concepts and skills that have been studied and strengthened by the existence of examples of applications and the linkage of concepts with other concepts In everyday life. Teachers can direct students to obtain alternative explanations using data or facts they explore in new situations as a step to further solidify students' conceptual understanding (Azhar, 2012).

This research aim to see student’s mathematical concept understanding who attend learning cycle 7E model better than student’s mathematical concept understanding who attend conventional learning in class X SMA 12 Padang.

METHOD

The type of research used in this study is quasy experimental research, where the research variables are not possible to be fully controlled. In accordance with the research, then used two classes of experimental class and control class. The design of this study using Static Group Design is in the experimental class is treated by applying the Learning Cycle 7E learning model, while the control class is not given treatment. At the end of the learning the two classes were given a final test of mathematical concept understanding based on the subject matter given during the study (Seniati, et al, 2011).

The population in this study is the students of class X SMA Negeri 12 Padang consisting of 11 classes. In this study required 2 sample classes, sampling is done randomly (random sampling) with draw. The draw is done by taking a roll of paper in which the name of the class X 1 to X 11 is written. After the sampling, the class X7 is obtained as experimental class and class X 9 as the control class.

Variable in this research consist of two, that is independent variable and dependent variable. The independent variable in this research is the treatment given to the experimental class, that is learning using learning cycle model 7E. The dependent variable in this research is the understanding of mathematical concepts of class X students of SMA Negeri 12 Padang in academic year 2015/2016.

Type of data in this study there are two primary data and secondary data. Primary data used is the data taken from the sample through the final test of mathematical concepts understanding to see the understanding of mathematical concepts of students from the experimental class and control class. Secondary data used is data about the number of students who become population and sample and the value of semester odd semester examination of grade X students of SMA Negeri 12 Padang in academic year 2015/2016.

The research procedure is divided into three stages: preparation stage, implementation stage, and final stage. In accordance with the problems in this study, the instrument used is the final test of mathematical concepts understanding. This test is used to obtain quantitative data in the form of the final value of mathematical concepts used to compare the student's mathematical concepts understanding between the experimental class and the control class. The material tested in the form of material given during the research took place that is Mathematical Logic. Before the test was given to a class of samples, testing the test item.

The data analysis technique used is the two equality test equation. Before carrying out the two-sided equality test, the requirement that needs to be met is that the data obtained from both samples are normally distributed and have homogeneous variance. Hypothesis testing performed under significant level. Based on the research that has been done, the samples are not normally distributed, the hypothesis test is done by non parametric statistics using Mann-Whitney U test. Tests were conducted using Minitab software assistance.

RESULTS OF RESEARCH AND DISCUSSION

This study was conducted six times a meeting and one mathematics test with the subject of Mathematical Logic. The research was conducted from February 29 to April 13, 2016. Description data of this research is the test data of mathematical concept understanding arise through essay test which done at end of research. The test was followed by 30 students in the experimental class and 29 students in the control class. Based on test results can be made in Table 1.

Table 1. Descriptive Statistics Test Results of Mathematical Concepts Understanding

Class	Total Students	Minimum	Maximum	Average	Standard Deviation
Experiment	30	47,92	95,83	77,15	12,05
Control	29	39,58	87,50	65,95	13,26

Based on Table 1 it is seen that the experimental class has an average test of 77.15 while the control class has an average test of 65.95 so it can be seen that the experimental class has an average test higher than the average in the control class. The standard deviation of the experimental class is lower than the control class, indicating that the value in the experimental class is more uniform and better than the control class because it has the same ability. In addition to the highest values of the two classes, the experimental class has a higher value than the control class, as well as the lowest values of the two classes.

Data test sample class understanding of the concept in more detail can be seen through each item in accordance with the indicators of test understanding of concepts being investigated. The students ability in each conceptual understanding indicator is scaled 0, 1, 2, 3, or 4 according to the criteria based on concept scoring rubric. The results of concept comprehension tests that have been expressed as percentages for the experimental class can be seen in Table 2.

Table 2. Percentage of Student's Mathematical Concepts Understanding of Experiment Class

Indicator	Ques. No.	Percentage of Students Obtaining Scale (%)				
		0	1	2	3	4
1	1	0,00	0,00	6,67	23,33	70,00
2	3(a)	3,33	3,33	3,33	6,67	83,33
	3(b)	0,00	36,67	23,33	16,67	23,33
	3(c)	3,33	16,67	10,00	16,67	53,33
3	2(a)	6,67	3,33	3,33	46,67	40,00
	2(b)	0,00	13,33	13,33	33,33	40,00
	2(c)	0,00	10,00	3,33	23,33	63,33
	2(d)	0,00	16,67	6,67	23,33	53,33
4	5	0,00	0,00	30,00	53,33	16,67
5	6	0,00	6,67	10,00	30,00	53,33
6	4	10,00	3,33	10,00	33,33	43,33
7	5	0,00	3,33	26,67	40,00	30,00

Based on Table 2, it can be seen that in some indicators, the percentage of students in the experimental class who got a scale of 4 more than 50% is on indicator 1, 2 (number 3a and 3c), 3 (question 2c and 2d,), and 5. In indicator 1, 2 (question 3b), 3 (item 2b, 2c, 2d), 4, 5, and 7 the students who get the scale 0 are 0.00%. Even on one of the questions from indicator 2, the percentage of students who scored 4 reached 83.33%. This means understanding the concept of students in the experimental class is good. While the percentage results for the control class can be seen in Table 3.

Table 3. Percentage of Student's Mathematical Concepts Understanding of Control Class

Indicator	Ques. No.	Percentage of Students Obtaining Scale (%)				
		0	1	2	3	4
1	1	0,00	3,45	3,45	41,38	52,72
2	3(a)	0,00	0,00	10,34	20,69	68,97
	3(b)	0,00	58,62	13,79	20,69	6.90
	3(c)	10,34	31,03	3,45	17,24	37,93
3	2(a)	0,00	3,45	31,03	27,59	37,93
	2(b)	0,00	3,45	17,24	44,83	34,48
	2(c)	0,00	10,34	27,59	27,59	34,48
	2(d)	6,90	6,90	24,14	24,14	37,93
4	5	0,00	0,00	37,93	51,72	10,34
5	6	0,00	17,24	41,38	24,14	17,24
6	4	3,45	6,90	20,69	44,83	24,14
7	5	0,00	34,48	27,59	24,14	13,79

Information:
1 : The ability to re-state a concept.
2 : The ability to classify objects according to certain traits according to concepts.
3 : The ability to set an example and not an example of a concept.
4 : The ability to present concepts in various forms of mathematical representation.
5 : The ability to develop necessary terms or sufficient conditions from a concept.
6 : Ability to use and utilize and choose specific procedures or operations.
7 : Ability to apply concepts or algorithms in problem solving.

Table 3 shows that in indicators 1, 2 (questions 3a and 3b), 3 (questions 2a, 2b, and 2c), 4, 5, and 7 students in the control class the scale 0 is 0.00%. In the control class the percentage of students who get a scale of 4 more than 50% is for indicators 1 and 2 (question number 3a). But on the second indicator that is the number 3b it can be seen that the percentage of students who get scale 1 reaches more than 50%. This means that there are still students in the control class who have not mastered the mathematical concepts understanding well.

Based on the description of Tables 2 and 3, from the two samples, the overall average of the scale of the indicators obtained by the experimental class is higher than the average obtained by the control class students. Hypothesis test that has been done proves that student's mathematical concepts understanding learning using learning cycle 7E is better than the student's mathematical concepts understanding learning using conventional learning. This is evident from the hypothesis test is done.

The learning model 7E learning cycle that has been applied to the experimental class influence on some indicators of student understanding of mathematical concepts, namely the concept of understanding the indicator to 1, 2, 3, 5, and 6. It is proven by the percentage of students in the experimental class were scored by a scale 4 more. Based on a description of the mathematical concepts of understanding indicators, it can be concluded that the students in the experimental class have demonstrated a better understanding than the students in the control class. This is influenced by the application of 7E learning cycle model in the learning process. The effect of the 7E learning cycle model on the students' understanding of mathematical concepts is due to the steps in this model giving the students a chance to discover the concept by themselves rather than being given directly by the teacher. So students can understand the concept better. From the discussion, it is also seen that there are some indicators that show the sample class students have a mathematical understanding of equivalent concepts. However, overall understanding of mathematical concepts of students learning by applying the learning model of learning cycle 7E is better than understanding the mathematical concepts of students learning by applying conventional learning.

An upgraded indicator is to re-state a concept, classify objects according to specific traits according to their concepts, provide examples and not examples of concepts, develop necessary terms or sufficient terms of a concept, and use, utilize, and select specific procedures or operations . As for other conceptual indicators of understanding that presents concepts in various forms of mathematical representation and applying concepts or algorithms in solving student problems in the experimental class still not showing significant improvement. This is because the students are still a lot less accurate in answering the questions given and in a hurry to do it.

Although in this study obtained the results of understanding the concept of mathematics in the experimental class is better than the understanding of mathematical concepts of students in the control class, but in its implementation can not be separated from the constraints and limitations encountered. The obstacles faced are in terms of time. This happened at the first meeting of the research that was held on Monday, because the math lesson was held after the flag ceremony, there was a delay in the hours of the day due to the length of the flag ceremony. As a result, the learning hours should start at 08.00 am, starting at 08.30 WIB.

To overcome these problems, the material studied is divided into two, namely open statements and sentences, so there are 4 groups that discuss the material about the statement, and the other group discusses the material about open sentences. The number of holidays, events held at school, and exam activities both mid semester and national examinations make lessons less effective. Therefore the students are given Homework (Homework) so that students can study at home repeat the material that has been learned and prepare the material to be learned at the next meeting. Another obstacle faced during the study is the length of time required by students in solving the problems that exist in the LKS, so that the time used less effective. To overcome this, any group that can complete the LKS faster and can present it in front of the class, given the added value. In addition, the lack of interest of students to read the instructions in the LKS, students tend to just solve the problems given, which resulted in students often ask again to the teacher what the purpose of the given problem. To overcome this, need to be reminded to each group to read in advance the commands contained in the LKS given, then just discuss the answer.

CONCLUSION

Based on the results of data analysis has been done, it can be concluded that the student's mathematical concept understanding who attend learning cycle 7E model better than student's mathematical concept understanding who attend conventional learning. This can be interpreted that the learning cycle 7E model gives a positive influence in improving student's mathematical concepts understanding.

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IMPROVING CRITICAL THINKING ABILITYBY USING GUIDED INQUIRY LEARNING WITH SAINTIFIC APPROACH

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Abstract

The current curriculum is the 2013 curriculum that uses the basic scientific approach. In the learning process students are required to play an active role especially in discovery activities, while the teacher who originally acted as a learning resource to switch the function of becoming a facilitator of learning activities that play a role (guiding) students to solve problems encountered in learning or find their own concepts Which is being studied. Scientific approaches include observing, asking, trying, processing, presenting, summarizing and creating for all subjects. To be scientific, the method of inquiry must be based on the evidence of observable, empirical, and measurable objects with specific principles of reasoning. Inquiri learning is a series of learning activities that emphasize the critical thinking process and analytical to seek and find their own answers to a questionable problem. The process of inquiry is done through the following stages: 1) orientation, 2) formulating the problem, 3) proposing the hypothesis, 4) collecting data, 5) testing the hypothesis, 6) formulating the conclusion. The main purpose is to encourage students in developing thinking skills by asking questions and getting answers based on their curiosity. The methodology used in this paper is the literature study. Based on the study, the process of learning mathematics with guided inquiry model based on scientific approach can develop critical thinking ability.

Keywords: *Guided Inquiry, Scientific Approach, Critical thinking ability*

INTRODUCTION

The curriculum according to Law No. 20 of 2003 is a set of plans and arrangements concerning objectives, content, and lesson materials and ways used as guidelines for the implementation of learning activities to achieve national education objectives. Based on the above information then to achieve the national education goals required a good curriculum, which can develop not only the character in the students themselves, but also the skills that exist in the students. Now the current curriculum is the 2013 curriculum that uses the basic scientific approach. The scientific approach consists of two words, the approach and the scientific. According to Yulianto (2013), the term approach comes from the English approach which means one is "Approach". In teaching, approach is defined as a way of beginning something 'how to start something'. Meanwhile, according to Big Indonesian Dictionary (2013), scientific is scientifically. From both the above explanation can be concluded scientific approach is a way to start learning and guidance of learning done scientifically.

The current scientific approach has the criteria of encouraging and inspiring learners to understand, apply, and develop rational and objective thinking patterns in response to learning materials based on empirical concepts, theories and facts that can be accounted for, the objectives of learning formulated in a simple and Clear, but interesting presentation system. Scientific learning not only views learning outcomes as the final estuary, but the learning process is considered very important. In the learning process students are required to play an active role especially in discovery activities, while the teacher who originally acted as a learning resource to switch the function of becoming a facilitator of learning activities that play a role (guiding) students to solve problems encountered in learning or find their own concepts Which is being studied. Scientific learning emphasizes process skills (Mendikbud, 2013).

Scientific approaches include observing, asking, trying, processing, presenting, summarizing and creating for all subjects (Permendikbud, 2013). The use of a scientific approach in applying the 2013 curriculum is appropriate with teachers encouraging students to systematically study science through observing, questioning, gathering information, processing, tasting, reasoning, drawing conclusions and communicating. With the learning process, students can have critical thinking skills in applying in everyday life (Leksono, 2013). The 2013 curriculum mandates the essence of a scientific approach in learning. The scientific approach is believed to be the golden tool for the development and development of students' attitudes, skills and knowledge. The scientific method refers to investigative techniques for phenomena or symptoms, acquires new knowledge, or corrects and integrates prior knowledge. To be scientific, the method of inquiry must be based on the evidence of observable, empirical, and measurable objects with specific principles of reasoning. (Mendikbud, 2013)

Math lessons should be given to all learners ranging from elementary to high school to equip them with logical, analytical, systematic, critical, creative, meticulous, effective and efficient thinking skills and the ability to work together in problem solving (Attachment Permendiknas No. 23 Year 2006). Because mathematics is one branch of science that has an important role in the development of science and technology, both as a tool in the application of other fields of science and in the development of mathematics itself.

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. This study contains about the ability of critical thinking, guided inquiry, and scientific approach

RESULTS AND DISCUSSION

Based on the results of literature studies that have been done, on mathematical material and critical thinking skills are two things that can not be separated, because mathematical material is understood through critical thinking, and critical thinking trained through learning mathematics (Labertus, 2009). Students need to be trained to think critically starting from basic education level. Rusiyanti (2011) stated that in learning mathematics critical thinking becomes a tool to gain understanding of knowledge material as well as competence. This will affect the quality of student learning which has an impact on the learning achievement in school. The lack of critical thinking ability in learning mathematics of students caused by several factors, one of the factors causing according to Zulkardi (2002) is a factor related to learning, for example the method of learning mathematics that is still focused on the teacher so that students tend to be passive and have no opportunity to think. The lack of variation in the use of learning methods leads to the tendency of passive students, less motivated in learning mathematics, and less optimized ability of students in critical thinking, creative, analytical and logical.

According to Wade, identify eight critical thinking characters, which include 1) formulate questions, 2) limit problems, 3) test data, 4) analyze opinions and biases, 5) avoid very emotional considerations, 6) avoid over-simplification , 7) consider various interpretations, 8) tolerate ambiguity. Learning will be successful if using learning methods that guide students to be able to think critically. According Sanjaya (2011: 196) argued that inquiri learning is a series of learning activities that emphasize the process of thinking critically and analytically to seek and find their own answers to a questionable problem. The inquiry process is done through the following stages: 1) orientation, 2) formulating the problem, 3) submitting the hypothesis, 4) collecting data, 5) testing the hypothesis, 6) formulating the conclusion (Sanjaya, 2011: 201). Inquiri method of learning is essentially a process of discovery or investigation. The main purpose is to encourage students in developing thinking skills by asking questions and getting answers based on their curiosity. The learning process changes from teacher dominated to domination by student (student dominated), because in guided inquiry is a more active learning is the student, while the teacher acts as a facilitator or mentor only.

Based on the above study, the inquiry stage with critical thinking character has relevance. Stage 1 on the inquiry is orientation, the teacher makes the introduction of learning. While in stage 2 that is formulating the problem, at this stage students will formulate the questions, conducted in accordance with the first critical thinking character. Phase 3 is to propose a hypothesis, at this stage students will limit the problem so as to form a hypothesis, done in accordance with the second critical thinking character. Phase 4 collects data, at this stage students will test the data they get, done according to the third critical thinking character. Stage 5 is to test the hypothesis, obtained by analyzing various opinions, conducted in accordance with the fourth critical thinking character. Stage 6 is the conclusion, at this stage students avoid emotional considerations, avoid over-simplification, consider interpretation, tolerate ambigius, done according to the fifth, sixth, and seventh critical thinking characters.

Guided inquiry method is a part of learning activity with constektual approach. Knowledge and skills acquired by students are expected not only from the results of remembering facts, but also from finding their own (syaiful Sagala, 2010: 89). According to Robert B. Sund, Leslie W. Trowbridge (in Fathurrohman, 2015: 106-107) guided inquiry learning is an inquiri learning strategy in which the teacher provides sufficient guidance or instruction to learners. In the teaching and learning process with guided inquiry learning model, students get the necessary guidance. They are generally guiding questions for students. This type of inquiry is used primarily in inexperienced learners with inquiry models. In the early stages given more new guidance then gradually less guidance.

Based on the character of critical thinking and learning process inquiry with a scientific approach has a relationship that is the same learning process that will produce the same ability indicators. From the above explanation it can be expected that guided inquiry learning with scientific approach can develop and improve students' critical thinking ability.

CONCLUSION

From the description above, it is known that inquiry learning with scientific approach runs every character contained in critical thinking ability. Therefore, inquiry learning with scientific approach can improve students' critical thinking ability.

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AN ANALYSIS OF STUDENT ERROR IN SOLVING MATHEMATICS EXERCISES BY USING NEWMAN'S ERROR ANALYSIS (NEA)

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Abstract

This research plan is aims to describe student's errors and causes in solving math problems using Newman's Error Analysis (NEA). Population of this research is student in senior high school or secondary levels with purposive sampling. NEA is a framework with simple diagnostic procedures that include (1) decoding, (2) comprehension (3) transformation (4) skill process and (5) encoding.Newman's developed diagnostic method is used to identify the category of errors on the answers of an essay test.Analysis technique of this research will using literature study with describe student's errors while doing math's exercises.

Keywords: *Student error, Newman's Error Analysis (NEA)*

INTRODUCTION

The mindset that mathematics is a very scary lesson has not changed. This is because many students have problem to learn mathematics which abstract matter. As revealed by Soedjadi (2000) suggests the characteristics of mathematics are: (1) has an abstract object matters; (2) based on agreement; (3) deductive mindset; (4) has a blank symbol of meaning; (5) attention to the general issues; (6) consistent in the system.

Mullis, et al (2012) stated that the achievements of Trends in International Mathematics and Science Stud (TIMSS) presented in the Ministry of Education and Culture's presentation in the 2013 public test shows that "Only 5% of Indonesian students can solve the mathematics exercises on high and advanced category ies (Requires reasoning). In another perspective, 78% of Indonesian students can only solve the mathematics exercises in the low category (concepts and memorization levels).From data of the Program for International Student Assessment (PISA) in 2009 (AriyadiWijaya; 2012) found that almost half of Indonesian students (43.5%) were unable to solve the simplest PISA task. 33.1% of Indonesian students can only solve the mathematics exercises from contextual problems given explicitly as well as all the data needed to do the problem properly. Only 0.1% of Indonesian students are able to develop and do mathematical modeling that demands thinking and reasoning skills.

Based on the data it can be concluded that the ability of Indonesian students in identifying and understanding the role of mathematics in life is still low. So it is necessary to attempt to describe the errors in solving math problems. Mistakes in solving math problems can be used to detect the difficulty of learning mathematics so as to find alternative solutions in solving math problems.

Analysis to find out what mistakes are mostly done and why the mistake always done by student are needs to do. Through the error analysis will be obtained form and cause of student error, so that teacher can give kind of aid to student. The mistakes made by our students need further analysis, in order to get a clear and detailed description of the students' weaknesses in solving math problems. Mistakes made by students can be used as a consideration of teaching in an effort to improve teaching and learning activities. The increase in learning and teaching activities is expected to improve student learning outcomes or achievement. One of the tools and ways to know or predict the student errors that can be used is error analysis with NEA procedure (Newman's Error Analysis). The newman procedure is a method that analysis errors in sentence problems. Thus method suppose that in the process of problem solving there are two kinds of abstacles that hinder students from arriving at correct answer: (1)decoding, (2) comprehension (3) transformation (4) process skill dan (5) encoding (Natchadan Satoshi, 2006).

METHOD

This research is a literature study. Literature study is a way used to collect data and sources related to the research topics. These data sources contain: Analysis Error and NEA. The sources are obtained from journals, books, proceedings, articles, research reports and internet sites.

RESULT AND DISCUSSION

One of the characteristics of mathematics is the mathematical object. Hudojo (1998) states that the objects of mathematics are facts, concepts and principles. While Bell (1978) divides the mathematical objects in two groups, first direct object and second indirect object. Direct objects are classified into facts, skills, concepts and principles. While indirect objects are classified over the transfer of learning, inquiry ability, problem-solving ability and appreciation for mathematical structure. In the learning of mathematics, the role of the teacher is very important to instill a correct understanding of the students about the mathematical objects mentioned earlier. Bell (1978) argues that a mathematics teacher should develop testing and observation techniques to assist students from their point of view of concepts and principles being taught.

In fact that not all mathematics learning objects can be understood and controlled by students. This can be seen from their ability to solve the problems given by the teacher. This unability results in mistakes made by students in solving math problems.

According to Sukirman the error is a deviation against the right thing that is systematic, consistent, or incidental in certain areas. While Rahmat (2006) students' mistakes in solving problems are concept errors, operating errors and careless mistakes. Based on the description can be concluded that the error is a form of deviation against the actual answer that is systematic.

Malau (1996) states that the causes of mistakes that students often make in solving mathematical problems can be seen from several things, among others, due to lack of understanding of prerequisite materials and subject matter learned, lack of mastery of mathematics language, misinterpret or apply formulas, miscalculations, Less conscientious and forget the concept. Hiebert and Levre (1986) stated that "Conceptual knowledge is characterized as the knowledge rich in relationship. It can be thought of as linked relationships as the prominent as discrete pieces of information ". In the opinion that conceptual knowledge is a knowledge rich in relationships. This relationship includes facts and properties so that all pieces of information are linked to a network.

To identify the error is done an analysis. According KBBI (1990) understanding of analysis is the investigation of an event (essay, deeds and asanya). Analysis has a purpose to know the situation sebanarnya. The errors of the students need to be analyzed further, so that we get a picture of the weaknesses of the students we test (Nurkancana: 1986). The form of analysis chosen to identify the error is Newman Error Analysis (NEA).

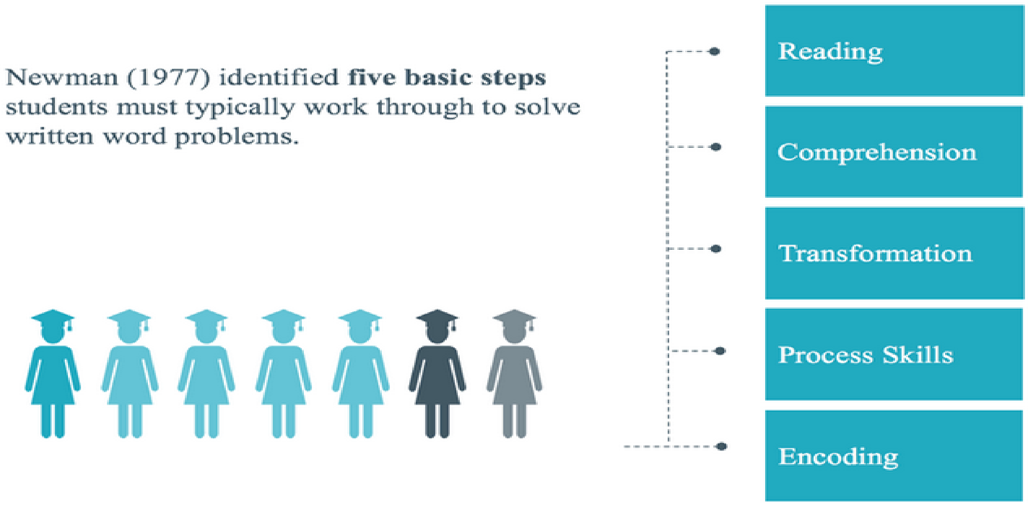
The newman procedure is a method that analysis errors in sentence problems. Thus method suppose that in the process of problem solving there are two kinds of abstacles that hinder students from arriving at correct answer: (1)decoding, (2) comprehension (3) transformation (4) process skill dan (5) encoding (Natchadan Satoshi, 2006).

The reasons for the inclusion of NEA Counting On programs were primarily to assist teachers when confronted with students who experienced difficulties with mathematical word problems. Rather than give students 'more of the same' involving drill and practice, NEA provided a framework for considering the reasons that underlay the difficulties and a process that assisted teachers to determine where misunderstandings occurred and where to target effective teaching strategies to overcome them. Moreover, it provided excellent professional learning for teachers and made a nice link between literacy and numeracy.

NEA was designed as a simple diagnostic procedure. Newman (1977, 1983) maintained that when a person attempted to answer a standard, written, mathematics word problemthen that person had to be able to pass over a number of successive hurdles: Level 1 Reading(or Decoding), 2 Comprehension, 3 Transformation, 4 Process Skills, and 5 Encoding.Newman defined five specific reading skills as crucial to performance on mathematical wordproblems. They are reading, comprehension, transformation, process skills, and encoding. She asked students the following questions (prompts) as they attempted problems.

IV. Please read the question to me. If you don't know a word, leave it out.
V. Tell me what the question is asking you to do.
VI. Tell me how you are going to find the answer.
VII. Show me what to do to get the answer. "Talk aloud" as you do it, so that I can understand how you are thinking.
VIII. Now, write down your answer to the question.

While working through a word problem it was always possible for students to make acareless error and there were some students who deliberately gave incorrect answers due to a lack of motivation to answer to their level of ability.



Picture 1. Newman identified five basic steps

Decoding steps, is an error that occurs because students cannot read or recognize the term in the matter, do not recognize the symbol or do not know the purpose of the problem. Step of comprehension, errors are analyzed is the students do not understand the terms, phrases or do not know the question comprehensively. Transformation steps, is an error that is analyzed is when the student is not able to change the information in question to the mathematical symbol. Process skill steps, student error analysis to student's inability to apply the calculation steps correctly when applying procedure or algorithm even though having successfully write mathematical sentence according to question asked. Encoding steps, is when students cannot write answers in the form of numbers, symbols or wordscorrectly even though it has been through the process skill steps.

CONCLUSION

NEA is a method that analysis errors in sentence problems. NEA maintained that when a person attempted to answer a standard, written, mathematics word problemthen that person had to be able to pass over a number of successive hurdles: Level 1 Reading(or Decoding), 2 Comprehension, 3 Transformation, 4 Process Skills, and 5 Encoding.

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APPLIED OF THIRD ORDER RUNGE KUTTA METHOD BASED ONCOMBINATION OF MEANS TO SOLVE FUZZY DIFFERENTIAL EQUATION*

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Abstract

This paper discuss about a numerical solution for fuzzy differential equation or fuzzy initial value problem by an application of third order Runge Kutta method based on combination of arithmetic, harmonic and geometric mean. The algorithm is illustrated by solving some linear and nonlinear fuzzy Cauchy problem. This numerical examples show that the new method work properly and give a competitive result.

***Keywords**: fuzzy differential equation, third order Runge Kutta method, fuzzy Cauchy problem*

INTRODUCTION

The concept of fuzzy derivative, which attracted a growing interest for some time, in particular, in relation to the fuzzy control, have been rapidly developed recent years. First order linear fuzzy differential equations are one of the simplest fuzzy differential equations, which appear in many applications. The concept of fuzzy derivative was first introduced by S.L.Chang and L.A.Zadeh in [15]. And the numerical method was introduced by M.Ma, M.FriedmandanA.Kandel [11] through Euler Method and Kanagarajan,K. and Suresh,R [9] modified this method. Runge Kutta method have also been studied by author [3,4,5,6,12,13,14].

The structure of this paper is organized as follows. In section 2, some basic results on fuzzy numbers and definition of a fuzzy derivative are given. In section 3, we define the problem that is a fuzzy Cauchy whose numerical solution is the main interest of this work. Solving numerically the fuzzy differential equation by the third order Runge Kutta method based on combination of means is discussed in section 4. The proposed algorithm is illustrated by some examples in section 5 and the conclusion is in section 6.

1. PreliminaryNotes

Consider the initial value problem

$$\begin{cases} y'(t) = f(t, y(t)); \ a \le t \le b \\ y(\alpha) = \alpha \end{cases}$$

The basis of all Runge Kutta method is to express the difference between the value oft_{n+1} and $t_n$as

$$y_{n+1} - y_n = \sum_{i=0}^{m} w_i k_i \qquad (1)$$

where w_i's are constants and

$$k_i = hf\left(t_n + a_i h, y_n + \sum_{j=1}^{i-1} c_{ij} k_j\right). \qquad (2)$$

The Runge Kutta method of order 3 based on combination of arithmetic, harmonic and geometric means is [16]

$$y_{n+1} = y_n + \frac{h}{90}\Big(7(k_1 + 2k_2 + k_3) - \Big(\frac{2k_1k_2}{k_1 + k_2} + \frac{2k_2k_3}{k_2 + k_3}\Big) + 32\big(\sqrt{k_1 + k_2} + \sqrt{k_2 + k_3}\big)\Big), \tag{3}$$

with

$$k_1 = f(t_n, y_n) \tag{4}$$

$$k_2 = f\left(t_n + \tfrac{2h}{3}, y_n + \tfrac{2h}{3}k_1\right) \tag{5}$$

$$k_3 = f\left(t_n + \tfrac{2h}{3}, y_n - \tfrac{4h}{9}k_1 + \tfrac{10h}{9}k_2\right), \tag{6}$$

where $a = t_0 \le t_1 \le \ldots \le t_N = b$ and $h = \dfrac{(b-a)}{N} = t_{i+1} - t_i$.

A triangular fuzzy number v is defined by three numbers $a_1 < a_2 < a_3$, where the graph of $v(x)$, the member function of the fuzzy number v, is a triangle with the base on the interval $[a_1, a_3]$ and the vertex at $x = a_2$. We specify v as $(a_1 / a_2 / a_3)$ and: (1) $v > 0$ if $a_1 > 0$; (2) $v \ge 0$ if $a_1 \ge 0$; (3) $v < 0$ if $a_3 < 0$; and (4) $v \le 0$ if $a_3 \le 0$.

Let E be a set of all the upper semicontinuous normal convex fuzzy numbers with bounded $r-$level sets. It means that if $v \in E$, then the $r-$level set

$$[v]_r = \{s | v(s) \ge r\},\ 0 < r \le 1,$$

is a closed bounded interval which is denoted by

$$[v]_r = [v_1(r), v_2(r)].$$

Let I be a real interval. The mapping $x : I \to E$ is called fuzzy process and its $r-$ level set is denoted by

$$[x(t)]_r = [x_1(t;r), x_2(t;r)],\ t \in I,\ r \in (0,1].$$

The derivative $x'(t)$ of the fuzzy process x is defined by

$$[x'(t)]_r = [x_1'(t;r), x_2'(t;r)],\ t \in I,\ r \in (0,1],$$

provided that this equation determines the fuzzy number.

Let κ be the set of all nonempty compact subsets of R and κ_c be the subset of κ consisting of nonempty convex compact sets. Recall that

$$\rho(x, A) = \min_{\alpha \in A} \|x - a\|$$

is a distance of the point $x \in R$ from $A \in \kappa$ and that the *Hausdorff separation* $\rho(A, B)$ of $A, B \in \kappa$ is defined as

$$\rho(A, B) = \max_{\alpha \in A} \rho(a, B).$$

2. A Fuzzy Cauchy Problem

Consider the fuzzy initial value problem

$$\begin{cases} y'(t) = f(t, y(t)),\ t \in I = [0, T] \\ y(0) = y_0 \end{cases} \tag{7}$$

where f is continuous mapping from $R_+ \times R$ into R and $y_0 \in E$ with r-level sets

$$[y_0]_r = [y_1(0;r), y_2(0;r)],\ r \in (0,1].$$

The extension principle of Zadeh leads to the following definition of $f(t,y)$ when $y = y(t)$ is a fuzzy number

$$f(t,y)(s) = \sup\{y(\tau) | s = f(t,\tau)\}, \ s \in R.$$

It follows that

$$[f(t,y)]_r = [f_1(t,y;r), f_2(t,y;r)], \ r \in (0,1],$$

where

$$f_1(t,y;r) = \min\{f(t,u) | u \in [y_1(r), y_2(r)]\},$$
$$f_2(t,y;r) = \max\{f(t,u) | u \in [y_1(r), y_2(r)]\}.$$

Theorem 3.1. Let f satisfy

$$\left| f(t,v) - f\left(t,\bar{v}\right) \right| \le g\left(t, \left|v - \bar{v}\right|\right), \ t \ge 0, \ v, \bar{v} \in R,$$

where $g : R_+ \times R_+$ is a continuous mapping such that $r \to g(t,r)$ is nondecreasing, the initial value problem

$$u'(t) = g(t, u(t)), \ u(0) = u_0, \qquad (8)$$

has a solution on R_+ for $u_0 > 0$, and that $u(t) = 0$ is the only solution of (8) for $u_0 = 0$. Then the fuzzy initial value problem (7) has a unique solution.

3. The Third Order of Runge Kutta Based on Combinations of Means

Let the exact solution $[Y(t)]_r = [Y_1(t;r), Y_2(t;r)]$ is approximated by some $[y(t)]_r = [y_1(t;r), y_2(t;r)]$. From (1) we define

$$y_1(t_{n+1};r) - y_1(t_n;r) = \sum_{i=1}^{3} w_i k_{i,1}(t_n, y(t_n;r)),$$
$$y_2(t_{n+1};r) - y_2(t_n;r) = \sum_{i=1}^{3} w_i k_{i,2}(t_n, y(t_n;r)),$$

where the w_i ‘s are constants and

$$[k_i(t, y(t;r))]_r = [k_{i,1}(t, y(t;r)), k_{i,2}(t, y(t;r))], \ i = 1,2,3$$
$$k_{i,1}(t, y(t;r)) = h.f\left(t_n + \alpha_i h, y_1(t_n) + \sum_{j=1}^{i-1} \beta_{ij} k_{j,1}(t_n, y(t_n;r)) \right),$$

$$k_{i,2}(t, y(t;r)) = h.f\left(t_n + \alpha_i h, y_2(t_n) + \sum_{j=1}^{i-1} \beta_{ij} k_{j,2}(t_n, y(t_n;r)) \right).$$

with

$$k_{1,1}(t, y(t;r)) = \min\{h.f(t,u) | u \in [y_1(t;r), y_2(t;r)]\}$$
$$k_{1,2}(t, y(t;r)) = \max\{h.f(t,u) | u \in [y_1(t;r), y_2(t;r)]\}$$
$$k_{2,1}(t, y(t;r)) = \min\left\{ h.f\left(t + \frac{2h}{3}, u \right) \middle| u \in [z_{1,1}(t, y(t;r)), z_{1,2}(t, y(t;r))] \right\}$$
$$k_{2,2}(t, y(t;r)) = \max\left\{ h.f\left(t + \frac{2h}{3}, u \right) \middle| u \in [z_{1,1}(t, y(t;r)), z_{1,2}(t, y(t;r))] \right\}$$

$$k_{3,1}(t,y(t;r)) = \min\left\{h.f\left(t+\frac{2h}{3},u\right) \middle| u \in \left[z_{2,1}(t,y(t;r)), z_{2,2}(t,y(t;r))\right]\right\}$$

$$k_{3,2}(t,y(t;r)) = \max\left\{h.f\left(t+\frac{2h}{3},u\right) \middle| u \in \left[z_{2,1}(t,y(t;r)), z_{2,2}(t,y(t;r))\right]\right\}.$$

Where in the Runge-Kutta method order 3 based on combination of arithmetic mean, harmonic mean and geometric mean,

$$z_{1,1}(t,y(t;r)) = y_1(t;r) + \frac{2}{3}k_{1,1}(t,y(t;r)),$$

$$z_{1,2}(t,y(t;r)) = y_2(t;r) + \frac{2}{3}k_{1,2}(t,y(t;r)),$$

$$z_{2,1}(t,y(t;r)) = y_1(t;r) - \frac{4}{9}k_{1,1}(t,y(t;r)) + \frac{10}{9}k_{2,1}(t,y(t;r))$$

$$z_{2,2}(t,y(t;r)) = y_2(t;r) - \frac{4}{9}k_{1,2}(t,y(t;r)) + \frac{10}{9}k_{2,2}(t,y(t;r)).$$

From Eq. (3), define

$$\begin{aligned} F[t,y(t;r)] &= \Bigg(7\left(k_{1,1}(t,y(t;r)) + 2k_{2.1}(t,y(t;r)) + k_{3,1}(t,y(t;r))\right) \\ &- \left(\frac{2k_{1,1}(t,y(t;r))k_{2,1}(t,y(t;r))}{k_{1,1}(t,y(t;r)) + k_{2,1}(t,y(t;r))} + \frac{2k_{2,1}(t,y(t;r))k_{3,1}(t,y(t;r))}{k_{2,1}(t,y(t;r)) + k_{3,1}(t,y(t;r))}\right) + 32\left(\sqrt{k_{1,1}(t,y(t;r)) + k_{2,1}(t,y(t;r))} \right. \\ &\left. + \sqrt{k_{2,1}(t,y(t;r)) + k_{3,1}(t,y(t;r))}\right)\Bigg) \end{aligned} \quad (9)$$

and

$$\begin{aligned} G[t,y(t;r)] &= \Bigg(7\left(k_{1,2}(t,y(t;r)) + 2k_{2.2}(t,y(t;r)) + k_{3,2}(t,y(t;r))\right) \\ &- \left(\frac{2k_{1,2}(t,y(t;r))k_{2,2}(t,y(t;r))}{k_{1,2}(t,y(t;r)) + k_{2,2}(t,y(t;r))} + \frac{2k_{2,2}(t,y(t;r))k_{3,2}(t,y(t;r))}{k_{2,2}(t,y(t;r)) + k_{3,2}(t,y(t;r))}\right) + 32\left(\sqrt{k_{1,2}(t,y(t;r)) + k_{2,2}(t,y(t;r))} \right. \\ &\left. + \sqrt{k_{2,2}(t,y(t;r)) + k_{3,2}(t,y(t;r))}\right)\Bigg). \end{aligned} \quad (10)$$

The exact and approximate solutions at t_n , $0 \le n \le N$ are denoted by $[Y(t_n)]_r = [Y_1(t_n;r), Y_2(t_n;r)]$ and $[y(t_n)]_r = [y_1(t_n;r), y_2(t_n;r)]$ respectively. The solutions is calculated by grid points at $h = \frac{b-a}{N} = t_{i+1} - t_i$. By (3) we have

$$Y_1(t_{n+1};r) \approx Y_1(t_n;r) + \frac{1}{90} F[t_n, Y(t_n;r)],$$
$$Y_2(t_{n+1};r) \approx Y_2(t_n;r) + \frac{1}{90} G[t_n, Y(t_n;r)]. \tag{11}$$

We define

$$y_1(t_{n+1};r) = y_1(t_n;r) + \frac{1}{90} F[t_n, y(t_n;r)],$$
$$y_2(t_{n+1};r) = y_2(t_n;r) + \frac{1}{90} G[t_n, y(t_n;r)].$$

The following lemmas will be applied to show convergence of these approximates, i.e.,

$$\lim_{h\to 0} y_1(t;r) = Y_1(t;r),$$
$$\lim_{h\to 0} y_2(t;r) = Y_2(t;r).$$

Lemma 4.1. *Let a sequence of numbers* $\{W_n\}_{n=0}^{N}$ *satisfy*

$$|W_{n+1}| \le A|W_n| + B, \quad 0 \le n \le N-1$$

for some given positive constants A and B. Then

$$|W_n| \le A^N |W_0| + B\frac{A^n - 1}{A-1}, \quad 0 \le n \le N-1.$$

The proof, using mathematical induction is straight forward.

Lemma 4.2. *Let the sequences of numbers* $\{W_n\}_{n=0}^{N}$ *and* $\{V_n\}_{n=0}^{N}$ *satisfy*

$$|W_{n+1} \le |W_n\| + A\max\{|W_n|, |V_n|\} + B,$$
$$|V_{n+1} \le |V_n\| + A\max\{|V_n|, |W_n|\} + B \tag{12}$$

for some given positive constants A and B, and denote

$$U_n = |W_n| + |V_n|, \quad 0 \le n \le N.$$

Then

$$U_n \le \overline{A^n} U_0 + \overline{B}\frac{\overline{A^n - 1}}{\overline{A} - 1}, \; 1 \le n \le N \tag{13}$$

where $\overline{A} = 1 + 2A$ *and* $\overline{B} = 2B$.

Proof. *From Eq. (12) we get*

$$|W_{n+1}| + |V_{n+1}| \le |W_n| + |V_n| + 2A(|W_n| + |V_n|) + 2B$$
$$= (1+2A)(|W_n| + |V_n|) + 2B$$

And by applying Lemma 4.1 for U_n, $0 \le n \le N$ *we conclude that Eq. (13) is valid.*

Let $F(t,u,v)$ and $G(t,u,v)$ are obtained by substituting $[y(t)]_r = [u,v]$ in (9) and (10)

$$F(t,u,v) = F[(t; y(t))]$$
$$G(t,u,v) = G[(t; y(t))].$$

The domain where F and G are defined is

$$K = \{(t,u,v) | 0 \le t \le T, \; -\infty < v < \infty, \; -\infty < u < v\}.$$

Theorem 4.3. *Let* $F(t,u,v)$ *and* $G(t,u,v)$ *belong to* $C^2(K)$ *and let the partial derivatives of* F *and* G *be bounded over* K. *Then, for arbitrary fixed* r, $0 \le r \le 1$, *the third order Runge-Kutta based on combination of means approximates of Eq. (11) converge to the exact solutions* $\underline{Y}(t;r)$ *and* $\overline{Y} = (t;r)$ *uniformly in* t.

Proof. *As an ordinary differential equations, it is sufficient to show*

$$\lim_{h\to 0} y_1(t_N;r) = Y_1(t_N;r),$$
$$\lim_{h\to 0} y_2(t_N;r) = Y_2(t_N;r),$$

where $t_N = T$. *For* $n = 0,1,\ldots,N-1$, *by using Taylor theorem we get*

$$Y_1(t_{n+1};r) = Y_1(t_n;r) + \frac{1}{90}F[t_n, Y_1(t_n;r), Y_2(t_n;r)] + \frac{22}{648}h^4 ML^3 + O(h^5),$$
$$Y_2(t_{n+1};r) = Y_2(t_n;r) + \frac{1}{90}G[t_n, Y_1(t_n;r), Y_2(t_n;r)] + \frac{22}{648}h^4 ML^3 + O(h^5).$$

denote

$$W_n = Y_1(t_n;r) - y_1(t_n;r),$$
$$V_n = Y_2(t_n;r) - y_2(t_n;r).$$

Hence from (9) and (10)

$$W_{n+1} = W_n + \frac{1}{90}\{F[t_n, Y_1(t_n;r), Y_2(t_n;r)] - F[t_n, y_1(t_n;r), y_2(t_n;r)]\}$$
$$+ \frac{22}{648}h^4 ML^3 + O(h^5),$$
$$V_{n+1} = V_n + \frac{1}{90}\{G[t_n, Y_1(t_n;r), Y_2(t_n;r)] - G[t_n, y_1(t_n;r), y_2(t_n;r)]\}$$
$$+ \frac{22}{648}h^4 ML^3 + O(h^5).$$

Then

$$|W_{n+1}| \le |W_n| + \frac{1}{45}Lh \cdot \max\{|W_n|, |V_n|\} + \frac{22}{648}h^4 ML^3 + O(h^5),$$
$$|V_{n+1}| \le |V_n| + \frac{1}{45}Lh \cdot \max\{|W_n|, |V_n|\} + \frac{22}{648}h^4 ML^3 + O(h^5),$$

for $t \in [0,T]$ *and* $L > 0$ *is a bound for the partial derivatives of* F *and* G. *Thus by Lemma 4.2*

$$|W_n| \le \left(1 + \frac{2}{45}Lh\right)^n |U_o| + \left(\frac{22}{648}h^4 ML^3 + O(h^5)\right)\frac{\left(1 + \frac{2}{45}Lh\right)^n - 1}{\frac{2}{45}Lh},$$

$$|V_n| \le \left(1 + \frac{2}{45}Lh\right)^n |U_o| + \left(\frac{22}{648}h^4 ML^3 + O(h^5)\right)\frac{\left(1 + \frac{2}{45}Lh\right)^n - 1}{\frac{2}{45}Lh},$$

where $|U_0| = |W_0| + |V_0|$. *In particular*

$$|W_n| \le \left(1+\frac{2}{45}Lh\right)^n |U_o| + \left(\frac{495}{648}h^3ML^3 + O(h^4)\right)\frac{\left(1+\frac{2}{45}Lh\right)^{\frac{T}{h}}-1}{L},$$

$$|V_n| \le \left(1+\frac{2}{45}Lh\right)^n |U_o| + \left(\frac{495}{648}h^3ML^3 + O(h^4)\right)\frac{\left(1+\frac{2}{45}Lh\right)^{\frac{T}{h}}-1}{L}.$$

Since $W_0 = V_0 = 0$, we obtain

$$|W_n| \le \left(\frac{495}{648}ML^3\right)\frac{e^{\frac{2}{3}LT}-1}{L}h^3 + O(h^4),$$

$$|V_n| \le \left(\frac{495}{648}ML^3\right)\frac{e^{\frac{2}{3}LT}-1}{L}h^3 + O(h^4),$$

and if $h \to 0$ we get $W_N \to 0$ and $V_N \to 0$ which complete the proof.

4. Numerical Examples

Now we will present some examples to show that our method works.

Example 5.1. Let us consider the nuclear decay equation $y'(t) = -\lambda \cdot y(t),\ y(0) = y_0$, where $y(t)$ is the number radionuclides present in a given radioactive material, λ is a decay constant and y_0 is the initial number of radionuclides. In the model, uncertainty is introduced if we have uncertain information on the initial number y_0 of radionuclides present in the material. Note that phenomenon of nuclear disintegration is considered a stochastic process, uncertainty being introduced by the lack of information on the radioactive material under study. In order to take into account the uncertainty we consider y_0 to be a fuzzy number.

Let $\lambda = 1,\ I = [0,0.1]$ and $y_0 = [\alpha - 1, 1 - \alpha]$. The exact solution is $y(t,\alpha) = [(\alpha - 1)e^t, (1-\alpha)e^t]$. The result of numerical approximate and its comparison with the exact solution at $t = 0.1$ is shown in the following tables.

Table 5.1

α	**Modified RK3 Method**		**Exact Solution**		**Error**	
	$y_1(t_i;\alpha)$	$y_2(t_i;\alpha)$	$Y_1(t_i;\alpha)$	$Y_2(t_i;\alpha)$	$\lvert y_1 - Y_1\rvert$	$\lvert y_2 - Y_2\rvert$
0	-1.1046	-0.9044	-1.1052	-0.9048	0.5487e-3	0.4553e-3
0.1	-0.9941	-0.8139	-0.9946	-0.8143	0.4939e-3	0.4098e-3
0.2	-0.8837	-0.7235	-0.8841	-0.7237	0.4390e-3	0.3642e-3
0.3	-0.7732	-0.6331	-0.7736	-0.6334	0.3841e-3	0.3187e-3
0.4	-0.6628	-0.5426	-0.6631	-0.5429	0.3293e-3	0.2732e-3

0.5	-0.5523	-0.4522	-0.5526	-0.4524	0.2744e-3	0.2276e-3
0.6	-0.4418	-0.3618	-0.4421	-0.3619	0.2195e-3	0.1821e-3
0.7	-0.3314	-0.2713	-0.3316	-0.2715	0.1646e-3	0.1366e-3
0.8	-0.2209	-0.1809	-0.2210	-0.1810	0.1098e-3	0.0911e-3
0.9	-0.1105	-0.0904	-0.1105	-0.0905	0.0549e-3	0.0455e-3
1	0	0	0	0	0	0

Example 5.2. Consider the fuzzy initial value problem,

$$\begin{cases} y'(t) = y(t),\ t \in [0,1], \\ y(0) = (0.75 + 0.25r, 1.125 - 0.125r),\ 0 < r \le 1. \end{cases}$$

The exact solution is given by

$$Y_1(t;r) = y_1(0;r)e^t,\ Y_2(t;r) = y_2(0;r)e^t$$

which at $t = 1$

$$Y_1(1;r) = [(0.75 + 0.25r)e, (1.125 - 0.125r)e],\ 0 < r \le 1.$$

The exact and approximate solutions by Euler's method and modified Runge Kutta method of order 3, are compared and plotted in the following tables.

Table 5.2

r	**Improved Euler's Method**		**Modified RK3 Method**		**Exact Solution**	
	$y_1(t_i;r)$	$y_2(t_i;r)$	$y_1(t_i;r)$	$y_2(t_i;r)$	$Y_1(t_i;r)$	$Y_2(t_i;r)$
0.01	1.9812	2.9705	2.0453	3.0544	2.0394	3.0578
0.1	2.0465	2.9377	2.1064	3.0237	2.1067	3.0241
0.2	2.1125	2.9047	2.1743	2.9897	2.1746	2.9901
0.3	2.1785	2.8717	2.2423	2.9558	2.2426	2.9561
0.4	2.2446	2.8387	2.3102	2.9216	2.3105	2.9222
0.5	2.3106	2.8057	2.3781	2.8877	2.3785	2.8882
0.6	2.3766	2.7727	2.4460	2.8537	2.4465	2.8542
0.7	2.4425	2.7396	2.5141	2.8198	2.5144	2.8202
0.8	2.5087	2.7066	2.5820	2.7858	2.5824	2.7862
0.9	2.5746	2.6736	2.6500	2.7518	2.6503	2.7523
1	2.6406	2.6406	2.7179	2.7179	2.7183	2.7183

CONCLUSION

In this work we have applied iterative solution of Runge Kutta Method of order three based on combination of arithmetic, harmonic and geometric means for numerical solution of fuzzy differential equations. It is clear that the method introduced with $O(h^3)$ works properly and performs better than Improved Euler's Method.

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CONFIRMATORY FACTOR ANALYSIS TO TEST THE VALIDITY OF THEORETICAL CONSTRUCTS ON STRUCTURAL EQUATION MODELING FOR LECTURER PERFORMANCE ASSESSMENT IN STT PAYAKUMBUH

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Abstract

Structural Equation Modeling (SEM) for lecturer performance assessment has been purposed to see how much the influence of pedagogic competence, professional competence, personality competence, and social competence toward lecturer performance. Theoritically, each component is a laten construct which measured by some indicator variables. Confirmatory factor analysis has been done to test validity each indicator variable to know those variables were valid variable to measure laten construct. Variable indicator was valid or achieve convergen validity if loading factor value was more than 0,5. Furthermore, it will be evaluated whether the hypothesized model was proper to use or not. The hypothesized model was available to use if chi-square, GFI, AGFI, and RMSEA value were achieve fit criteria.

Keywords: *laten construct, indicator variable, loading factor*

INTRODUCTION

Lecturer's performance in an academy is a real action that performed by every lecturer as performance achievement done based on their role as professional worker which has function to improve national education quality. There are four competences which lecturer should be have; pedagogic competence, professional competence, personality competence, and social competence (Dikti: 2015).

Lecturer's performance assessment in Technology Academy of Payakumbuh was using students' perseptional assessment toward lecturer activity during whole semester periode 2016/ 2017 by means of questionnaire admission filling about some questions which involves the four competences that should be have by lecturer to measure lecturer's performance in a whole. The instrument used was certification educator for lecturer, each variable measured in scale 7 likert likert very low, not enough, minus, enough, good, very good, absolutely very good. (1, 2, 3, 4, 5, 6, 7).

Based on description above, a research has been done to modelling a connection to measure the influence of four competences; pedagogic competence, professional competence, personality competence and social competence toward lecturer's performance.

Pedagogic competence, professional competence, personality competence, and social competence were laten variable which formed based on theoritical concept with some indicators or manifest, therefore testing is needed to test whether they are valid indicators as latent constructors (Ghazali, 2011).

LITERATURE REVIEW

The Structural equation modeling is a statistical modeling technique that combines confirmatory factor analysis with path analysis or regression.

2.1 Confirmatory Factor Analysis

Confirmatory Factor Analysis is used to test the validity of a theoritical construct of hypothesized model. Models hypothesized based on theoritical concept consists of one or more laten variables measured by one or more indicator variables. Laten variables are unmeasurable indirectly measurable variables and require indicator variables to measure them. Through the Confirmatory Factor Analysis will be tested whether these indicators are valid indicators to measure latent variables.

Common model of Confirmatory Factor Analysis as follow:

$$\mathbf{x} = \Lambda_x \xi + \boldsymbol{\varepsilon}$$

$\mathbf{x}$ is vector of the indicator variables

Λ is Loading factor matrix (λ)

ξ is Vectors for latentvariables

ε is Measurement error vector

2.2 Validity Test

In confirmatory factor analysis, a hypothesized model have to achieve convergent validity which means factor loading value > 0,5.

2.3 Model Evaluation

Evaluation model have to do to value hypothesized model already proper to used or not. These are some proper test used to test properity a model (Sharma, 1996 in Maiyanti, 2008)

	Expected value	conclusion
Chi-Square	small	Fit Model
P-value	$\geq$ 0.05	Fit Model
AGFI	$\geq$ 0.8	Fit Model
GFI	$\geq$ 0.9	Fit Model
RMSEA	$\leq \geq$ 0.08	Fit Model

RESEARCH METHODOLOGY

This research was survey research, the data collected by using questionnaire students' perseptional assessment toward lecturer's performance during whole semester 2016/ 2017 in Computer Technique major Payakumbuh Technology Academy.

3.1 Steps in Research

Hair et all (1998) in Ghozali (2011) divide the steps in structural modeling as follow:

- Develop model theoretically or conceptualitation model

  Arrange concept to connect laten variable with another laten variable and its indicator either. Model specification become measurement model and structural model. Measurement model specification involves activity defined laten variables

Tabel 1. Endogenous Latent Variables and Indicators

Endogenous Latent Variable		Indicators
Lecturer Performance	KD1	Lecturer performance overall
	KD2	Discipline conduct lectures according to lecture schedule

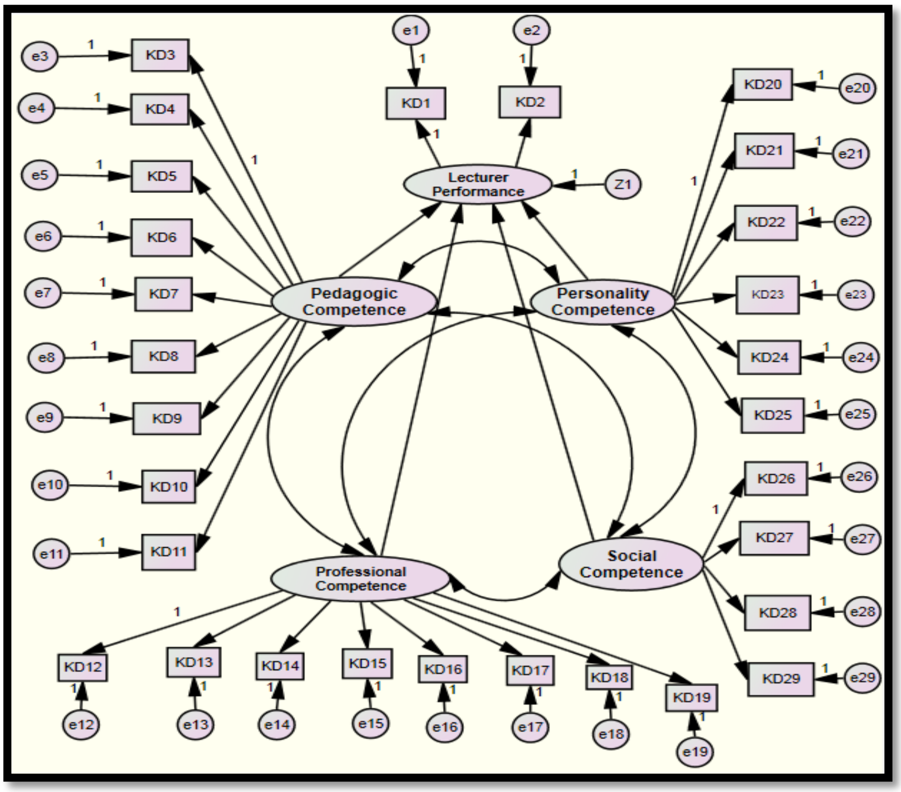
Tabel 2. Exsogenous Latent Variables and Indicators

Exsogenous Latent Variable		Indicators
Pedagogic Competence	KD3	Readiness to give lectures and / or practice / lab work
	KD4	Regularity and ordering of lectures
	KD5	Ability to live the classroom
	KD6	Clarity of material delivery and answers to questions in class
	KD7	Utilization of media and learning technology
	KD8	Diversity of measurement / assessment of learning outcomes
	KD9	Providing feedback on assignments / assessments
	KD10	The suitability of the exam and / or task materials with the purpose of the course
	KD11	Conformity of value provided with learning outcomes
Professional Competence	KD12	Ability to explain the subject or topic appropriately
	KD13	Ability to provide relevant examples of the concepts taught
	KD14	Ability to explain the relevance of field / topic that is taught with other fields / topics
	KD15	Ability to explain the relevance of the field / topic taught to the context of life
	KD16	Ruling on up-to-date issues in the taught field (Material updates / reference lectures)
	KD17	Use of research results to improve the quality of lectures
	KD18	Student involvement in research / study and / or development / engineering / design by lecturers
	KD19	Ability to use various communication technologies
Personality Competence	KD20	Authority as a personal lecturer
	KD21	Wisdom in decision making
	KD22	Be an example in behaving and behaving
	KD23	Only words and actions
	KD24	The ability to control oneself in various situations and conditions
	KD25	Fair in treating students
Social Competence	KD26	Ability to receive criticism, suggestions and opinions from students
	KD27	Familiar with the students who follow the lecture
	KD28	Easy to get along with colleagues, employees and stude
	KD29	Tolerance to the diversity of students

- Create Path Diagram

  The Path Diagram is a digram connected free variable, mediator and dependent variable. Path diagram used to describe effect directly and not directly of some variables as cause variable toward some other variables as effect variable. The pattern of that connection showed using an arrow.

- Single arrow shows cause-effect connection between exogen variables and one or more endogen variable. This arrow also connecting the error (residual variable) with all endogen variables.
- Double arrows shows correlation between exogen variable pairs.



Picture 1. Path Diagram Lecturer Performance Student's Perseptional

Picture description:

a. There were 4 exogen laten variables; pedagogic competence, professional competence, personality competence, and social competence. Eah of them symbolized with (ksi) $\xi_1, \xi_2, \xi_3,$ dan ξ_4. Each is measured by several indicator variables with an error value symbolized by *e.b.*There was 1 endogen laten variable; lecturer's performance that symbolized with η (eta) Measured by two indicator variables, with error values e_1 and e_2.

b. Among exogen laten variable have to covarianted by connecting both laten variable ith 2 arrows (covariant connection or correlation) symbolized with φ (phi).

Pedagogic competence ↔ professional competence symbolized with ϕ_{12}

Pedagogic competence ↔ personality competence symbolized with ϕ_{13}

Pedagogic competence v social competence symbolized with ϕ_{14}

Professional competence ↔ personality competence symbolized with ϕ_{23}

Professional competence ↔ social competence symbolized with ϕ_{24}

Personality competence $\leftrightarrow$ social competence symbolized with ϕ_{34}

Endogen laten variable (z1) have to give error or regression residual value with symbol δ

c. Regression coefficient among exogen laten variable with endogen laten variable
Pedagogic competence $\rightarrow$ lecturer's performance symbolized with γ_1

Profesional competence $\rightarrow$ lecturer's performance symbolized with γ_2

Personality competence $\rightarrow$ lecturer's performance symbolized with γ_3

Social competence $\rightarrow$ lecturer's performance symbolized with γ_4

- Interpreting Line Diagram into Equation
  Structural equation model consists of two models, they are structural and measurement model.
  - Structural Model
    Structural model describes about connection among laten variable.
    The form of structural model in this research are as follows:

$$\text{Lecturer Performance} = \gamma_1 \text{Pedagogic. C} + \gamma_2 \text{Professional. C} + \gamma_3 \text{Personality. C} + \gamma_4 \text{Social.C}$$

In matrix form:

$$\text{Lecturer performance} = \begin{bmatrix} \gamma_1 & 0 & 0 & 0 \\ 0 & \gamma_2 & 0 & 0 \\ 0 & 0 & \gamma_3 & 0 \\ 0 & 0 & 0 & \gamma_4 \end{bmatrix} \begin{bmatrix} \text{Pedagogic.C} \\ \text{Professional.C} \\ \text{Personality.C} \\ \text{Sosial.C} \end{bmatrix}$$

  - Measurement model
    Measurement model describes about laten variable connection with observed variables or indicator variables.

    The form of measurement model in this research are as follow:

$$
\begin{aligned}
\text{KD1} &= 1.\text{Lecturer Performance} + e_1 \\
\text{KD2} &= \lambda_1.\text{Lecturer Performance} + e_2 \\
\text{KD3} &= 1.\text{Pedagogic.C} + e_3 \\
\text{KD4} &= \lambda_2.\text{Pedagogic.C} + e_4 \\
&\vdots \\
\text{KD11} &= \lambda_9.\text{Pedagogic.C} + e_{11} \\
\text{KD12} &= 1.\text{Professional.C} + e_{12} \\
\vdots \quad & \vdots \quad \vdots \\
\text{KD19} &= \lambda_{16}.\text{Professional.C} + e_{19}
\end{aligned}
$$

KD20 = $1.\text{Personality.C} + e_{20}$

$\vdots \quad \vdots \quad \vdots$

KD25 = $\lambda_{21}.\text{Personality. C} + e_{25}$

KD26 = $1.\text{Social.C} + e_{26}$

$\vdots \quad \vdots \quad \vdots$

KD29 = $\lambda_{24}.\text{Social.C} + e_{29}$

In matrix foam

$$\begin{bmatrix} KD1 \\ KD2 \\ KD3 \\ KD4 \\ KD5 \\ KD6 \\ KD7 \\ KD8 \\ KD9 \\ KD10 \\ KD11 \\ KD12 \\ KD13 \\ KD14 \\ KD15 \\ KD16 \\ KD17 \\ KD18 \\ KD19 \\ KD20 \\ KD21 \\ KD22 \\ KD23 \\ KD24 \\ KD25 \\ KD26 \\ KD27 \\ KD28 \\ KD29 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \lambda_1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & \lambda_2 & 0 & 0 & 0 \\ 0 & \lambda_3 & 0 & 0 & 0 \\ 0 & \lambda_4 & 0 & 0 & 0 \\ 0 & \lambda_5 & 0 & 0 & 0 \\ 0 & \lambda_6 & 0 & 0 & 0 \\ 0 & \lambda_7 & 0 & 0 & 0 \\ 0 & \lambda_8 & 0 & 0 & 0 \\ 0 & \lambda_9 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & \lambda_{10} & 0 & 0 \\ 0 & 0 & \lambda_{11} & 0 & 0 \\ 0 & 0 & \lambda_{12} & 0 & 0 \\ 0 & 0 & \lambda_{13} & 0 & 0 \\ 0 & 0 & \lambda_{14} & 0 & 0 \\ 0 & 0 & \lambda_{15} & 0 & 0 \\ 0 & 0 & \lambda_{16} & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & \lambda_{17} & 0 \\ 0 & 0 & 0 & \lambda_{18} & 0 \\ 0 & 0 & 0 & \lambda_{19} & 0 \\ 0 & 0 & 0 & \lambda_{20} & 0 \\ 0 & 0 & 0 & \lambda_{21} & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & \lambda_{22} \\ 0 & 0 & 0 & 0 & \lambda_{23} \\ 0 & 0 & 0 & 0 & \lambda_{24} \end{bmatrix} \begin{bmatrix} \text{Lecturer Performance} \\ \text{Pedagogic.C} \\ \text{Professional.C} \\ \text{Personality.C} \\ \text{Social.C} \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \\ e_6 \\ e_7 \\ e_8 \\ e_9 \\ e_{10} \\ e_{11} \\ e_{12} \\ e_{13} \\ e_{14} \\ e_{15} \\ e_{16} \\ e_{17} \\ e_{18} \\ e_{19} \\ e_{20} \\ e_{21} \\ e_{22} \\ e_{23} \\ e_{24} \\ e_{25} \\ e_{26} \\ e_{27} \\ e_{28} \\ e_{29} \end{bmatrix}$$

- Identification Model
  Information gathered based on the data collected was tested to decide the model can be estimated or not. The model that already achieved requisite to analyzed was over identified model. (Ghozali, 2011). Over identified model, if $t \le \frac{s}{2}$ and *degree of freedom* (df > 0) where:
  t= the number of parameters in estimation
  s= number of variants and covariance between manifest variables (p+q).(p+q+1)
  p= number of endogenous latent variable indicator

q= number of exogenous latent variable indicator

The number of parameters estimated in this model is 68 parameters consisting of:

λ_1 λ_2 λ_3 λ_4 λ_5 λ_6 λ_7 λ_8 λ_9 λ_{10} λ_{11} λ_{12} λ_{13} λ_{14} λ_{15} λ_{16} λ_{17}

λ_{18} λ_{19} λ_{20} λ_{21} λ_{22} λ_{23} λ_{24} γ_1 γ_2 γ_3 γ_4 e_1 e_2 e_3 e_4 e_5 e_6

e_7 e_8 e_9 e_{10} e_{11} e_{12} e_{13} e_{14} e_{15} e_{16} e_{17} e_{18} e_{19} e_{20} e_{21} e_{22} e_{23}

e_{24} e_{25} e_{26} e_{27} e_{28} e_{29} ξ_1 ξ_2 ξ_3 ξ_4 ϕ_{12} ϕ_{13} ϕ_{14} ϕ_{23} ϕ_{24} ϕ_{34} δ

Known value t= 68, p= 2, q= 27and s= (p+q). (p+q+1)=(29).(30) *So* $68 \le \frac{29x30}{2} \le 435$

then the model is over identified with $df = \frac{(p+q)(p+q+1)}{2} - t = \frac{29x30}{2} - 68 = 367$

ANALYSIS AND DISCUSSION

Indicators (manifest variable) were tested as a valid laten construct measurement by using confirmatory factor analysis.

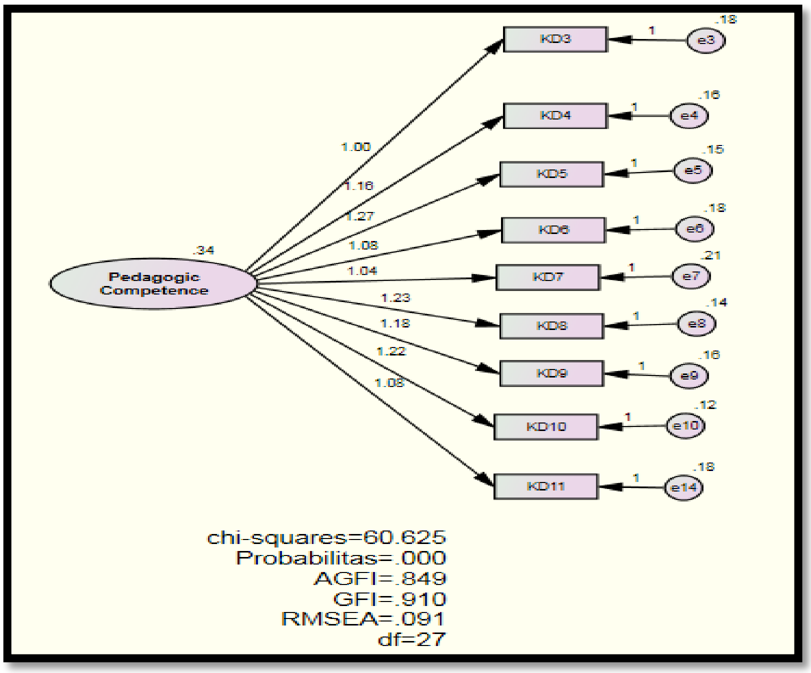
4.1 Data Description

The basic assumption of structural equation modeling as continued data and interval scale minimum.The data research was ordinal data with likert scale 1-7. According to Joreskog (2002) ordinal data in this research has to treat as ordinal data, not as continued data, so that analysis methode used was Generalized least Square (GSL). Successive interval was used to converse ordinal data become interval data.

4.2 Confirmatory Factor Analysis

a. Confirmatory test of exogenous constructs pedagogic competence

The result of processing confirmatory test for this construct was as follow:



Picture 2. Confirmatory Factor Analysis Pedagogic Competence

			Estimate	S.E.	C.R.	P	Label
KD3	<---	Pedagogic_Competence	1.000				
KD4	<---	Pedagogic_Competence	1.165	.092	12.696	***	
KD5	<---	Pedagogic_Competence	1.270	.105	12.097	***	
KD6	<---	Pedagogic_Competence	1.084	.098	11.110	***	
KD7	<---	Pedagogic_Competence	1.043	.093	11.246	***	
KD8	<---	Pedagogic_Competence	1.225	.106	11.585	***	
KD9	<---	Pedagogic_Competence	1.183	.099	11.946	***	
KD10	<---	Pedagogic_Competence	1.221	.103	11.810	***	
KD11	<---	Pedagogic_Competence	1.077	.103	10.482	***	

Based on convergen validity value, all loading factors value were more than 0.5 so that it can be concluded all indicators were valid to measure competence pedagogic laten variable.

The p-value was less than 0.05 it means that there were differences between population covariant variant matrix and sample covariant variant matrix. AGFI, GFI, and RMSEA value were almost close to expected value. Moreover, it can be concluded that model was fit and proper to be used.

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Universitas Negeri Padang, West Sumatera Indonesia
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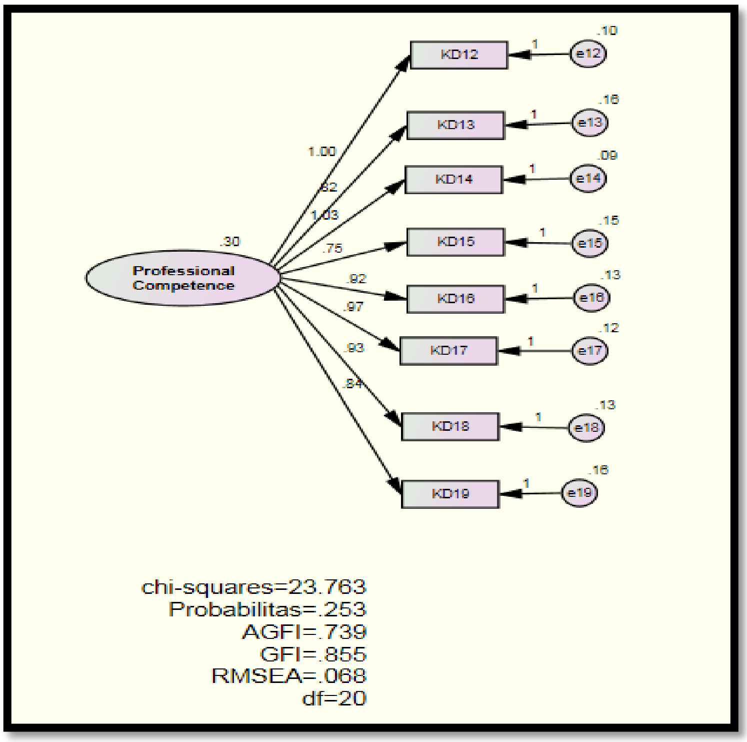
b. Confirmatory test of exogenous constructs Professional competence



Picture 3. Confirmatory Factor Analysis professional Competence

			Estimate	S.E.	C.R.	P	Label
KD12	<---	Professional_Competence	1.000				
KD13	<---	Professional_Competence	.821	.141	5.822	***	
KD14	<---	Professional_Competence	1.029	.188	5.481	***	
KD15	<---	Professional_Competence	.752	.175	4.299	***	
KD16	<---	Professional_Competence	.925	.181	5.122	***	
KD17	<---	Professional_Competence	.970	.214	4.523	***	
KD18	<---	Professional_Competence	.935	.167	5.583	***	
KD19	<---	Professional_Competence	.840	.189	4.440	***	

Based on convergen validity value, all loading factors were more than 0.5 so that it can be concluded that all indicators were valid to measure professional competence laten variable.

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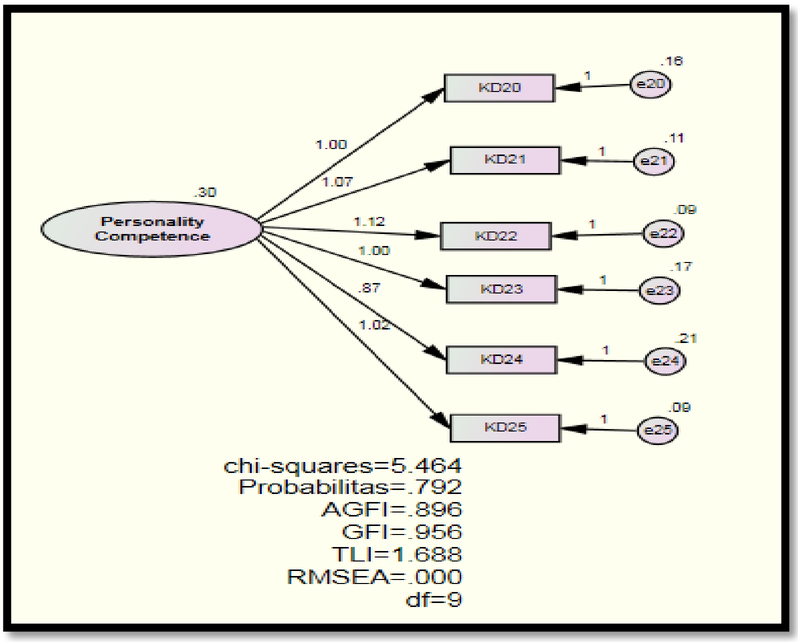
c. Confirmatory test of exogenous constructs personality competence

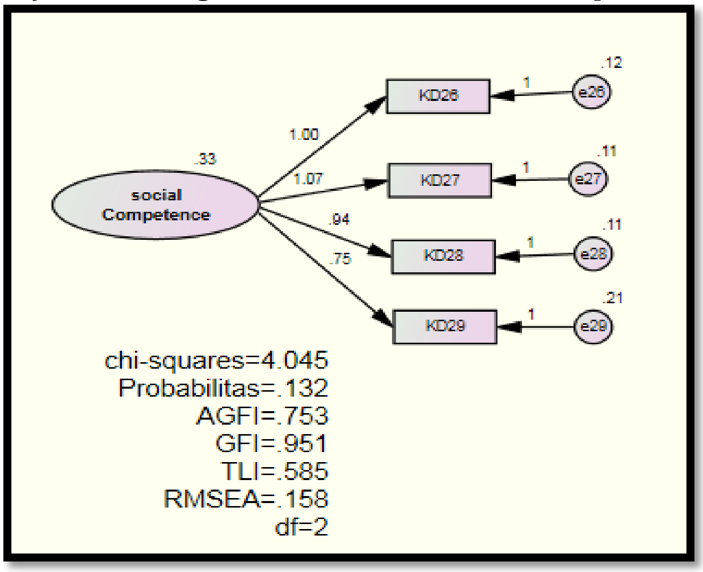


Picture 4. Confirmatory Factor Analysis personality competence

			Estimate	S.E.	C.R.	P	Label
KD20	<---	Personality_Competence	1.000				
KD21	<---	Personality_Competence	1.074	.190	5.643	***	
KD22	<---	Personality_Competence	1.121	.161	6.967	***	
KD23	<---	Personality_Competence	1.003	.189	5.312	***	
KD24	<---	Personality_Competence	.866	.169	5.126	***	
KD25	<---	Personality_Competence	1.016	.152	6.664	***	

All loading factors value were more than 0.5 so that it can be concluded that all indicators were valid to measure personality competence laten variable.

d. Confirmatory test of exogenous constructs sosial competence



Picture 5. Confirmatory Factor Analysis Sosial Competence

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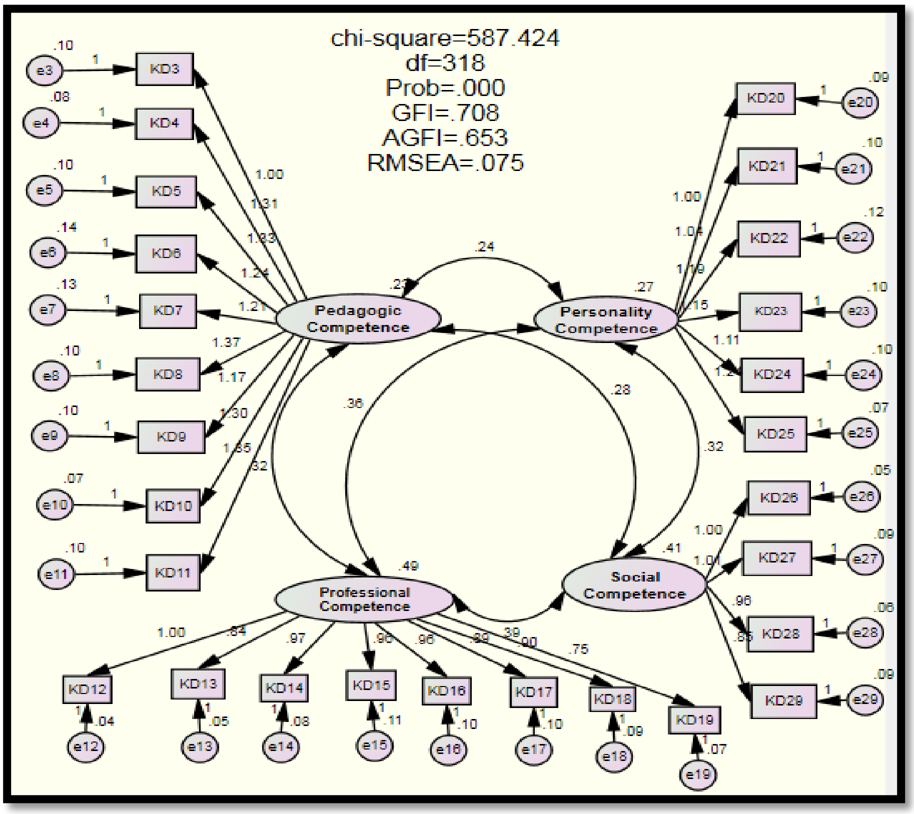
			Estimate	S.E.	C.R.	P	Label
KD26	<---	social_Competence	1.000				
KD27	<---	social_Competence	1.067	.161	6.633	***	
KD28	<---	social_Competence	.937	.153	6.111	***	
KD29	<---	social_Competence	.748	.161	4.658	***	

All loading factors value were more than 0.5 so that it can be concluded that all indicators were valid to measure social competence laten variable.

e. Confirmatory test among exogen construct



Picture 6. Confirmatory Factor Analysis among exogen construct

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
KD3	<---	Pedagogic_Competence	1.000				
KD4	<---	Pedagogic_Competence	1.308	.121	10.791	***	
KD5	<---	Pedagogic_Competence	1.329	.133	10.030	***	
KD6	<---	Pedagogic_Competence	1.240	.130	9.533	***	
KD7	<---	Pedagogic_Competence	1.210	.124	9.763	***	
KD8	<---	Pedagogic_Competence	1.368	.139	9.810	***	
KD9	<---	Pedagogic_Competence	1.174	.121	9.714	***	
KD10	<---	Pedagogic_Competence	1.302	.132	9.844	***	
KD11	<---	Pedagogic_Competence	1.347	.146	9.227	***	
KD15	<---	Professional_Competence	.957	.086	11.106	***	
KD20	<---	Personality_Competence	1.000				

			Estimate	S.E.	C.R.	P	Label
KD21	<---	Personality_Competence	1.040	.092	11.341	***	
KD22	<---	Personality_Competence	1.188	.112	10.571	***	
KD23	<---	Personality_Competence	1.145	.111	10.364	***	
KD24	<---	Personality_Competence	1.114	.120	9.254	***	
KD25	<---	Personality_Competence	1.235	.121	10.181	***	
KD26	<---	Social_Competence	1.000				
KD27	<---	Social_Competence	1.014	.078	13.043	***	
KD28	<---	Social_Competence	.956	.081	11.805	***	
KD29	<---	Social_Competence	.853	.074	11.509	***	
KD14	<---	Professional_Competence	.972	.076	12.797	***	
KD13	<---	Professional_Competence	.835	.063	13.345	***	
KD16	<---	Professional_Competence	.959	.080	11.917	***	
KD17	<---	Professional_Competence	.891	.082	10.861	***	
KD18	<---	Professional_Competence	.904	.081	11.177	***	
KD19	<---	Professional_Competence	.746	.081	9.208	***	
KD12	<---	Professional_Competence	1.000				

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Pedagogic_Competence	<-->	Personality_Competence	.241	.050	4.816	***	
Professional_Competence	<-->	Social_Competence	.387	.061	6.386	***	
Pedagogic_Competence	<-->	Social_Competence	.276	.052	5.250	***	
Pedagogic_Competence	<-->	Professional_Competence	.324	.054	5.995	***	
Personality_Competence	<-->	Social_Competence	.316	.060	5.228	***	
Professional_Competence	<-->	Personality_Competence	.355	.059	6.039	***	

Variances: (Group number 1 - Default model)

	Estimate	S.E.	C.R.	P	Label
Pedagogic_Competence	.228	.052	4.373	***	
Professional_Competence	.487	.074	6.599	***	
Personality_Competence	.274	.063	4.356	***	
Social_Competence	.408	.072	5.671	***	

All loading factors were more than 0.5 so that it can be concluded that all indicators were valid to measure social competence laten variable.

P-value was less than 0.05 it means that there were some differences between population covariant variant matrix and sample covariant variant matrix. The value of AGFI, GFI, and RMSEA were almost close to expected value. So that it can be concluded that the model was fit and proper to be used.

CONCLUSIONS AND SUGGESTIONS

Conclusions

1. Confirmatory Factor Analysis toward all laten variables showed that all loading factors from each indicator variable were more than 0.5 which means that all indicators variable used to measure each laten variable were valid or achieve convergent validity and can be used in model.
2. The value of Goodness of fit of the model was less fit compared with expected value, but totally it was already fulfill fit criteria. So, the model of line diagram which proposed can be used as lecturer's performance assessment model by students.
3. Confirmatory factor analysis among exogen laten variable only can be done to measure the data more than 150, not for small data.

Suggestions

The use of Generalized Least Square (GLS) still limited for data sample with format more than 150. Based on the data research, the sample gathered was less than 100 so that the estimation model suggested for lecturer's performance modelling was Bayesian estimation, especially for small sample with ordinal data and normality assumption uncompleted.

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THE INFLUENCE OF REALITIC MATHEMATICS EDUCATION APPROACH ON STUDENT'S MATHEMATICAL ABILITY VIEWED FROM THE LEARNING STYLES DIFFERENCE

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Abstract

Mathematic education needs to be more focus on exploring students'mathematical communication and representation skills in order to improve the students' achievements in mathematics. Mathematic education needs to mind the learning style difference.The purpose of this reseach was to find out the influence of RME approach on mathematical communication and representation skill. This was a quasi experimental researchthat has been conducted at class VIII SMP in Bukittinggi. By using simple random sampling technique, two class was choosen as the experiment class and as the control class from the high, middle and low schools level.The hypotheses of the research was tested by using u-test Mann Withney and h-test Kruskal Wallis. Based on the result of data analysis is concluded: (1) student's mathematical communication and representation skill by using RME approach is better than student's mathematical communication and representation skill by using conventional approach, (2) there is no significant difference between auditory, kinesthetic, and visual student's learning style in mathematical communication and representation skill, and (3) there is interaction between learning approach and learning style in student's mathematical communication and representation skill. The RME approach is more effective for the kinesthetic's students to influence the mathematical communication and representation skill.

Keywords – *mathematic communication, matematic representation, RME, learningstyle*

INTRODUCTION

Mathematics is one of the disciplines of science and technology subjects. The position of mathematics is recognized to have a major influence on other disciplines and has an important role in various aspects of life. Mathematics is taught to students at every level of education in Indonesia by making it a compulsory subject at school. Students are prepared to have the ability to think logically, critically, creatively, innovatively, and affectively and able to contribute to the life of society, nation, state, and world civilization. Mathematics learning in schools is expected to equip students to have good basic math skills so they can apply in everyday life.

The basic mathematical skills that students must possess include problem-solving abilities, reasoning and verification, communication, connections, and representation [1]. The process of learning mathematics is expected to provide space to students to be able to present the mathematical concepts he has learned into various forms of mathematical models to solve mathematical problems they encounter. This can be fulfilled by providing opportunities for students to develop mathematical communication and representation skills.

mathematical communication and representation skills are important skills to be developed in high school students. Students who have good communication skills will be able to make a variety of representations that make it easier for them to find alternative solutions. Communication skills and good representation will have an impact on the increased ability to solve mathematical problems.

The ability of mathematical communication is the ability of students in using mathematics as a communication tool (mathematics language) and the ability of students to communicate the math learned as the content of the message to be conveyed [2]. It is important for students to have good mathematical communication skills in order to understand mathematical concepts so that they are able to solve mathematical problems. Good communication process has the potential to trigger students to develop ideas and build mathematical knowledge [3].

The ability of mathematical representation is the key of communication skills. students will have good communication skills if they are able to represent their mathematical ideas. Representation is a new form as a result of translations of the problem or idea of translations or ideas into the form of visual images or translations from diagrams or physical models into symbols Or words [1]. Students who have good mathematical representation skills will support them to organize their thoughts to communicate their ideas to a given mathematical problem.

The expectation that students have good mathematical communication and representation skill, is inversely related to the facts that occur in the field based on several studies that have been done. The ability of Indonesian students is ranked 64 out of the 72 participating countries that participated in the 2015 International Program for Student Assessment (PISA) research [4]. PISA is a form of evaluation of skills and knowledge designed for 15-year-old students. Skills and assessed abilities include math, reading, and science. These results indicate that Indonesian students still have low mathematical ability, since the questions tested on PISA are both contextual and non-routine. Completion of non-routine questions require students to communicate their ideas and represent them.

PISA research results reinforced by several research results that show that the ability of students in representing and communicating is still low and need to be developed. Preliminary research conducted by Hutagol [5] states that the ability of representation of students, especially junior high school students is still less developed. The mathematical communication ability of Indonesian students is still low [6].

Along with the results of the above research, the final examination of the subjects of mathematics subjects mathematics class VIII academic year 2016/2017 at one of Junior High School in Bukittinggi City is still less satisfactory. Based on the final semester test data from the three classes obtained, two classes of them are still below the minimum completeness criterion with an average value of 66.70 and 54.06. In the final exam of the semester given to the students there are questions that require mathematical communication and representation skills to solve them. So it can indicate that mathematical communication and representation skills of students are still not well developed.

The cause of low mathematical communication and representation skills that gives the greatest impact is the strategies and learning methods used in schools. Based on the results of interviews with one of the teachers who teach in one of Junior

High School in Bukittinggi City, it was revealed that the learning done in the classroom did not give space to the students to be able to communicate and represent their ideas. The learning that occurs only in the form of one and two-way learning only. This is due to the teacher's belief that, if giving students the opportunity to communicate and represent their ideas will take a lot of time, so that learning objectives can not be met thoroughly. Along with that, teachers in mathematics-related learning representations still use conventional means, so students tend to imitate the teacher's steps, students are never given the opportunity to present the ability of mathematical representation [7].

In addition to learning process factors, the lack of mathematical communication and representation skills of students also influenced by individual factors and demographic factors of students, such as the difference in learning styles. Teachers pay less attention to how the delivery of materials in accordance with learning styles that are owned by students Learning styles owned by students also have an influence in building mathematical communication skills. Research conducted revealed that students' style of learning affects the ability of mathematical communication in solving the problem of mathematical description [8]. The results of this study was accompanied by the disclosure that students who have visual learning styles have higher communication skills than students with auditory and kinesthetic learning styles.

To overcome these impacts, a more meaningful mathematics learning is needed so that it can facilitate students who have different learning styles to develop mathematical communication and representation skill. Mathematical learning given to students is expected to provide space for students to express their ideas to the solution of the mathematical problems they encountered. As expressed by Pugalee [9] that in learning mathematics students need to be accustomed to provide an argument of each of their answers And responding to the answers of others, so that the learning process becomes meaningful. In line with Pugalee, [10] states that in order to improve mathematically conceptual understanding, students can be trained by bringing their mathematical ideas to others.

Mathematical learning using problems with a context will enhance the mathematical communication skills of students [11]. RME is a learning approach that uses realistic problems in the form of contextual problems that exist in the real world and can be found in the daily life of students as well as real in the minds of students. One characteristic of the RME approach is interactive activity. Through this interactive activity is expected students get room to train their mathematical communication skills. By working in groups, students have the opportunity to exchange ideas and arguments so they can learn from each other [12].

Learning with the RME approach will also provide opportunities for students to practice their representational skills. At the end of the discussion, students are given the opportunity to choose which settlement they want. Representative forms that have been chosen students can facilitate it in presenting or solving problems encountered.

The characteristics of RME in the form of the use of context, the use of models for progressive mathematization, the utilization of students' constructive outcomes, interactivity and relevance are expected to facilitate students with visual learning, auditory, and kinesthetic styles as a whole in the learning process of mathematics. In learning with RME approach students who have a visual learning style will be given the opportunity to learn by serving the problem in the form of sentences, diagrams, drawings and tables. While students with auditory learning style will be facilitated by interactivity process where students will communicate their work and ideas in the discussion process. Students with kinesthetic learning style will be facilitated by the learning process of doing the math problems given.

It is expected that the RME approach will facilitate students with different learning styles to develop mathematical communication and representation skill. This study aims to describe (1) differences in mathematical communication and representation skills of students using RME and conventional approaches, (2) differences in mathematical communication and representation skills of students with auditory, kinesthetic, and visual learning styles, and (3) The interaction between the learning approach and the learning style of the student.

RESEARCH METHODS

The effect of learning treatment with RME approach on mathematical communication and representation skill of students will be seen through quasi experimental research. There are two groups in this study that is experimental group treated with the approach of RME and control group treated with the learning with conventional approach.

The sample is determined by using purposive sampling technique by considering research schedule and recommendation of mathematics subject teacher. Selected three schools with top, middle and lower level. Each school selected two classes as an experimental and control class. Class VIIIG was selected as experimental class and VIIIF as control class at SMP N 1 Bukittinggi as high school. At the middle school level selected SMP 5 Bukittinggi with class VIII6 as the experimental class and class VIII4 as the control class. Class VIII1 was selected as experimental class and class VIII2 as control class at SMP N 7 Bukittinggi as lower level school. The data used in this study is primary data in the form of learning outcomes of students obtained after treatment is given, and secondary data is data taken indirectly from other parties, namely from the math teacher in each school.

The independent variables in this research are RME approach, while mathematical communication and representation skill of VIII students of State Junior High School of Bukittinggi as dependent variable. Moderator variables in this study are learning style.

The procedure in this study is to carry out the learning in accordance with the design of learning that has been made then provide the final test to measure mathematical communication and representation skills after treatment is given. The test results are measured using scoring rubrics, with indicators of communication skills that are: (1) expressing mathematical situations or everyday events into mathematical models and solving them, (2) expressing mathematical models (images, algebraic expressions) into plain language (3) explaining mathematical models and / or patterns, (4) analyzing and evaluating mathematical thinking and strategies used by others. The indicators used to measure the ability of mathematical representation are: (1) presenting data or information from a representation to a representation of diagrams, graphs, or tables, (2) creating equations or mathematical models of other representations provided, and (3) writing interpretations Of a

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representation. The learning style of the students is determined by using a questionnaire to determine the learning style of the students using a questionnaire adapted from the learning style test developed [13].

RESULTS AND DISCUSSION

After the research is done, the distribution of mathematical communi-cation and representation of the result of communication ability test and the mathematical representation result is presented in Table 1.

Table 1

Results Of Mathematical Communication And Representation Tests Of Participants Classified Samples

School Level	Sample Class	Communication Ability	Representation Ability
High	Experiment	82,143	78,571
	Control	68,750	56,173
Middle	Experiment	67,578	65,625
	Control	54,492	59,635
Low	Experiment	68,958	79,444
	Control	69,952	55,769

Table 1. shows that the experimen-tal class has a higher average than control class in mathematical communication ability as well as mathematical representa-tion capability, for upper level school, middle school, and lower level school. The standard deviation of the lower experimental class compared with the standard deviation of the control class indicates that the value of the communication ability test and the experimental class representation are more uniform than the control class.

Data of mathematical communication and representation ability test result of sample student in analysis using U Mann Withney test. Obtained sig. Smaller than the real level ($\alpha = 0.05$), then reject H0 and accept H1. This means that there is an average difference in the results of mathematical communication and representation skills tests of experimental class students and control class at high school and middle school levels.

After collecting data on learning styles of students obtained the data communication and representation tests in terms of differences in learning styles that can be seen in Table 2 and Table 3.

Table 2Data Tests Mathematical Abilities Participants Learned From Difference Learning Differences

School Level	Sample Class	Learning Style	Communication Ability	Representation Ability
Atas	Experiment	Auditory	81,25	74,245
		Kinesthetic	82,813	91,668
		Visual	82,692	78,206
	Control	Auditory	67,411	52,381
		Kinesthetic	75	63,333
		Visual	67,188	58,333
Tengah	Experiment	Auditory	68,75	57,639

School Level	Sample Class	Learning Style	Communication Ability	Representation Ability
		Kinesthetic	70	73,333
		Visual	63,75	67,5
	Control	Auditory	55,208	60,417
		Kinesthetic	53,125	56,25
		Visual	54,688	61,111
Bawah	Experiment	Auditory	71,635	76,282
		Kinesthetic	64,179	72,515
		Visual	64,732	82,143
	Control	Auditory	69,922	56,25
		Kinesthetic	72,917	55,556
		Visual	68,75	54,762

In Table 2 it is seen that in upper level schools the average score of students' communication ability test with kinesthetic learning style in the experiment and control class is higher than the value of communication ability test of students with auditory and visual learning style. While at the middle school level the average score of communication ability tests of students with kinesthetic learning style in the experimental class is higher than that of students with auditory and visual learning styles. Whereas in control class the mean value of communication ability test of students with higher auditory learning style compared with students with kinesthetic and visual learning style. Meanwhile in lower level school the average score of communication ability test of students with auditory learning style in experiment class is higher compared with students with kinesthetic and visual learning style. In the control class the average score of communication ability tests of students with a kinesthetic learning style is higher than that of students with auditory and visual learning styles.

The average score of representation skills of high school students with kinesthetic learning styles in the experimental and control classes is higher than the value of the student's representation skills tests with auditory and visual learning styles. While at the middle school level the average score of representation skills of students with kinesthetic learning style in the experimental class is higher than that of students with auditory and visual learning style. Whereas in the control class the average score of representation ability test of students with visual learning style is higher compared to students with auditory and kinesthetic learning style. Meanwhile in lower level schools the average score of representation ability of students with visual learning style in the experimental class is higher than that of students with auditory and kinesthetic learning style. In the control class the average score of the student's representation ability test with higher auditory learning style compared with the students with kinesthetic and visual learning style.

Data of communication ability test result and mathematical representation of sample student lecturer in analysis using H Kruskal Wallis test. Obtained sig. Greater the real level ($\alpha = 0.05$), then accept H0. This means that there is no significant difference between mathematical communication and representation skills of students with different learning styles at the upper, middle, and lower level schools.

After interaction test using interaction graph it can be seen that the effect of learning approach factor and the effect of learning style factor on mathematical communication and representation skills have intersecting line, then reject H1 and receive H0. This means that there is an interaction between learning approaches and learning styles in influencing the mathematical communication ability of students.

Because of the interaction between learning approach and learning style in influencing mathematical communication and representation skills of students, further analysis is done to find out what effect factors are actually different from others. The analysis is done by looking at the average difference of each combination. Based on further analysis results obtained that the RME approach is more effective for students with auditory and kinesthetic learning styles, and conventional approaches are more effective for students with visual learning styles, in influencing the mathematical communication skills of students. In addition, the RME approach is more effective for students with kinesthetic learning styles, and conventional approaches are more effective for students with auditory and visual learning styles in influencing the mathematical representation of students.

The mathematical communication ability of experimental class students for indicators 1, 2, 3 and 4 can be said to be at a satisfactory level with few shortcomings. The mathematical communication ability of the students in the control class is at satisfactory level with few disadvantages for indicator 1. While for indicator 2, 3, and 4 students keas control can be said to have a level of mathematical communication ability is quite satisfactory but there are still many shortcomings. The ability of the mathematical representation of experimental class students for indicators 1, 2, and 3 are at satisfactory levels with few shortcomings. The ability of the mathematical representation of students in the control class is at a satisfactory level with few disadvantages for indicator 2. While for indicators 1 and 3 control class students can be said to have a mathematical representation level that is quite satisfactory but there are still many shortcomings.

Based on data descriptions and data analysis, it is known that learning using RME approach gives positive influence to mathematical communication and representation skills of students. The mathematical communication and representation skills of students following learning by using the RME approach is better than the mathematical communication and representation skills of students following the conventional learning.

It can be seen from the average of mathematical communication and representation skills test result of students who follow the learning with RME approach is higher than the mathematical communication and representation skills of students who follow the conventional learning. The difference is caused in the experimental class of students facilitated to train mathematical communication and representation skills both in finding the concept and solve problems given. Therefore it can be said that the mathematical communication and representation skills of students who follow the learning with RME approach better. This is in line with what is stated [12] by working in groups, students have the opportunity to exchange ideas and arguments so they can learn from each other.

Mathematical learning using an effective RME approach is used for students with an auditory learning style in influencing mathematical communication skills. Students with auditory learning styles have learning characteristics by listening and remembering what is being discussed rather than being viewed, liking to discuss and explaining things at length, enjoy reading aloud and listening, and liking to talk [14].

Through learning by using RME approach students with auditory learning style can be facilitated with group discussion activities in the learning. In the group discussion activity occurs the process of interactivity that became one of the characteristics of RME. In accordance with those disclosed by Treffers [15] that interaction in mathematics learning is useful in developing cognitive and affective abilities, in which students will communicate their work and ideas in the process of discussion.

Learning with the RME approach will also provide opportunities for students to practice their representational skills. At the end of the discussion, students are given the opportunity to choose which settlement they want. Representative forms that have been chosen students can facilitate it in presenting or solving problems encountered.

The RME approach gives better results to students with a kinesthetic learning style in influencing the ability of mathematical representation. This means an effective RME approach is used for students with a kinesthetic learning style.

Students with kinesthetic learning styles have learning characteristics through manipulation and practice, like plot-oriented books, and want to do something [14]. Through learning by RME approach the students with facilitated kinesthetic learning style with activities are given in the learning. One characteristic of RME is the presence of group activities of students that provide interactivity opportunities. In accordance with those disclosed by Treffers [15] that interaction in mathematics learning is useful in developing cognitive and affective abilities. Group activities are facilitated by the student's Worksheet. It is therefore suspected as a factor that the RME approach is more effective for students with a kinesthetic learning style in influencing mathematical communication and representation skills.

CONCLUSION

Based on the results of research and discussion on the conclusion that the mathematical communication and representation skills of students who learn with RME learning approach is better than the mathematical communication skills of students who learn with conventional learning. This means that the RME learning approach has a good impact on the communication skills of students in upper and middle schools.There is no significant difference between learning approaches with different learning styles in influencing mathematical communication and representation skills of students. This means that students' different learning styles differ in the level of communication skills of each student with auditory, kinesthetic, and visual learning styles at upper, middle, and lower level schools.

There is an interaction between learning approaches and learning styles in influencing mathematical communication and representation skills of students in lower level schools. The RME approach is more effective for students with auditory and kinesthetic learning styles, and conventional approaches are more effective for students with visual learning styles in influencing the mathematical communication skills of students. The RME approach is more effective for students with kinesthetic learning styles, and conventional approaches are more effective for students with auditory and visual learning styles in influencing the mathematical representation skills of students.For Students with visual learning style more effective learning using conventional approach. Most learners have a visual learning style. In mathematics learning in the classroom students are more likely to remember with what they see in the form of diagrams, images, tables, films, or materials conveyed by teachers [16]. This is what is thought to be a factor that the conventional approach is more effective for learners with visual learning styles in influencing communication skills and mathematical representation.

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THE FORMATION OF MATHEMATICAL MODELS OF TORCH DISEASE TRANSMISSION

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Abstract

TORCH is an infection caused by Toxoplasma, Rubella, Cytomegalovirus (CMV) and Herpes simplex virus. TORCH transmitted through 2 ways that is passive (congenital) and active (obtained). TORCH is capable of attacking various age groups. This disease does not cause death in adults, but in pregnant women can lead to defects in the fetus or miscarriage. In addition, it also disrupts the fertility of men and women. Because TORCH is highly contagious and seriously affected, investigations are conducted to determine the factors or parameters that influence the spread of TORCH. Finally, in this article the mathematical model is formed by determining the assumptions, parameters and variables based on theories and problems found.

Index Terms— differential equations, mathematical models, TORCH, virus

INTRODUCTION

An outbreak of disease is a very crucial issue for a country because of its enormous impact. One of them is TORCH disease. TORCH is a term that refers to infection caused by (Toxoplasma, Rubella, Cytomegalovirus (CMV) and Herpes simplex virus II (HSV-II) in pregnant women.TORCH stands for (Toxoplasma, Rubella, Cytomegalovirus (CMV) and Herpes simplex virus consisting of HSV 1 and HSV 2 and possibly by other viruses whose clinical effects are more limited (eg Measles, Varicella, Echovirus, Mumps, Vaccinia virus, Polio virus and Coxsackie-B virus).

Toxoplasma is not a virus, so it is not transmitted through sexual intercourse to a partner. Toxoplasma can be infectious in offspring (eg pregnant women to babies who are born later). While Rubella, CMV, and Herpes can be transmitted to a partner (husband or wife) through sexual intercourse, because it is a virus. In addition to sexual intercourse, the transmission of Rubella, CMV, and Herpes can also be through saliva, sweat, urine, blood, and breast milk (ASI) so that if women experience Rubella, CMV and Herpes then her husband can also be infected.

TORCH transmission in humans can be through 2 ways that is actively (obtained) and passively (congenital). Transmission actively occurs when swallowing oosysts and cysts, whereas passive transmission occurs via the placenta from mother to child (Wishnuwardhani, 1990) in Sitepu 2011. Transmission actively can be due to several things: 1) Eat half-cooked meat coming from infected animals (containing sista). For example beef, goat, chicken, and others. The greatest likelihood of TORCH transmission to humans is through this pathway through half-baked cooking, 2) Eating foods oosisticated and costes of cats suffering from TORCH. Feces of cats that contain oosysts will pollute the soil (environment) and can be a source of transmission in both humans and animals. The high risk of TORCH infection through contaminated soil caused by oosystas can survive in the soil up to several months, 3) Blood transfusion (trofozoid), organ transplantation, or tissue graft (trozoid, cyst), laboratory accidents that cause TORCH to enter the body or accidentally enter through the wound. (Remington and Mcleod 1981, and Levine 1987) in Sitepu 2011, 4) Sexual intercourse between men and women, 5) Pregnant women suffering from TORCH when pregnant may have children suffering from placenta-borne TORCH 6) Breast milk in mothers suffering from TORCH , 7) Sweat clinging to the clothes or that is still attached to the skin, 8) The habit of eating raw vegetables, and fresh fruits that are washed less clean, eat without washing hands first, consuming food and drinks are served without a lid, so the possibility of contamination of oosystas greater, 9) Saliva that way of transmission is almost the same as the transmission of sexual intercourse.

Based on the above exposure, the disease is highly contagious. Therefore, in one family usually if one of the family members affected by the disease then the other also can be affected. The main causes are mostly animals around us such as cats, chickens, birds, mice, goats, cows, dogs, pigs, and others that contain TORCH viruses and parasites in their blood. The animals can be either direct carriers or as intermediaries (indirect carriers). Indirect carrier through its dirt containing TORCH contaminates the soil, so it can also contaminate the vegetables that grow on the ground. Animal waste infected with TORCH can fly away with flies, insects or birds and stick to food, then the food goes into the human mouth and lives in human blood.

The danger of this disease is that it can interfere with fertility not only for women, but also for men. In TORCH women infect the egg cell so that the egg or cell nucleus become damaged by the virus so that the egg cell is smaller and can not be fertilized. Such infections in women can also cause the formation of myomas, blockage or adhesion of the oviduct, so that the egg can not be fertilized and lead to difficult pregnancy. While in men, TORCH infects sperm cells that will worsen and decrease sperm quality, decrease sperm viscosity, and decrease the motility of sperm cells making it difficult to reach the egg.

For pregnant women, the disease can be transmitted to the baby, which can cause miscarriage and threaten the safety of the fetus to be born later (the baby is born disabled). TORCH infection along with radiation exposure and teratogenic drugs can cause damage to the embryo. Some fetal deformities that can arise due to TORCH that attacks pregnant women include abnormalities in the nerves, eyes, abnormalities in the brain, and etc.

Finally, this research discuss about mathematical model of diseases transmission. Its' start from formation model based on parameter, variable and assumption using theories.

METHOD AND DESIGN

The research is a basic (theoretical) research. The method used is the analysis of theories relevant to the issues discussed. The steps taken are to study the phenomenon of the problem, collect and link the theories related to the problem, determine the appropriate assumptions with the problems, define the variables and parameters used, to form and analyze the model, and interpret the results of model analysis obtained to answer the problem.

FINDINGS AND DISCUSSION

1.1. Form a Model

The population consists of 3 groups. They are susceptible group (S), infected group (I), and recover group (R). Assumption of the model:

a. The presence of natural death is death that is not caused by the disease in question
b. The presence of death caused by disease
c. Any individual born from a vulnerable group is assumed to be susceptible to TORCH disease
d. Any individual born from an infected group of diseases is assumed to be directly infected by the disease (vertical transmission, from mother to baby through the placenta)
e. Individuals who have recovered from TORCH disease may be re-infected by TORCh disease due to weakened immune system (cure is not permanent)
f. Transmission of TORCH disease in 2 ways, ie
    1) Passively (vertical). Transmission of the disease from the mother to her baby through the placenta
    2) Actively (obtained). Sexually transmitted diseases, saliva, blood transfusions, sweat, eating oosista-tainted foods, eating half-baked foods derived from infected animals, etc.

Parameter that use in model: α is the birth rate; β_1 is the rate of transmission caused by direct contact between S and I, for example through sexual intercourse; β_2 is the rate of indirect transmission, for example through eating food contaminated with oosystis, blood transfusions, organ transplants, etc; γ_1 is the level of individuals recovering from TORCH; γ_2 is the level of individuals re-infected with TORCH disease due to a weak immune system due to HIV disease or other; μ_1 is the natural rate of death; and μ_2 is the death rate due to TORCH disease

The general overview of model showed in flow diagram.

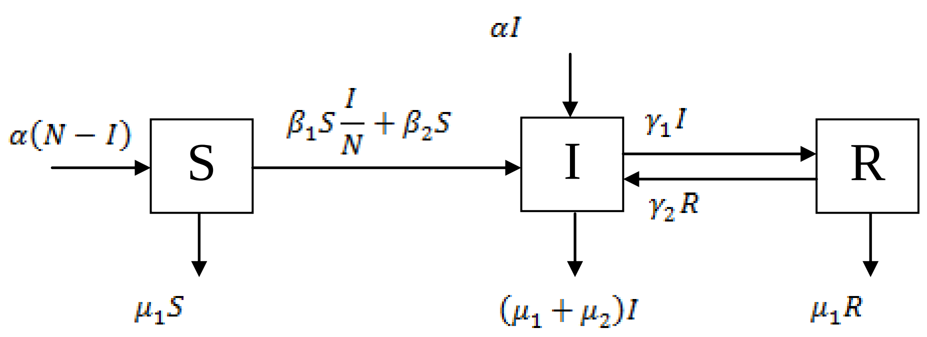

Figure 1. Flow diagram of model

Here, the mathematical model formula. That is system (1)

$$\frac{dS}{dt} = \alpha(N-I) - S\left(\beta_1\frac{I}{N} + \beta_2 + \mu_1\right),$$

$$\frac{dI}{dt} = S\left(\beta_1\frac{I}{N} + \beta_2\right) + \gamma_2 R - (\mu_1 + \mu_2 + \gamma_1 - \alpha)I, \qquad (1)$$

$\frac{dR}{dt} = \gamma_1 I - (\mu_1 + \gamma_2)R,$

with $N = S + I + R$

after that, to simplify system (1) let $S = Ns$, $I = Ni$, and $R = Nr$ so we get system (2):

$$\frac{ds}{dt} = \alpha(1 - i) - s(\beta_1 i + \beta_2 + \mu_1),$$

$$\frac{di}{dt} = s(\beta_1 i + \beta_2) + \gamma_2 r - (\mu_1 + \mu_2 + \gamma_1 - \alpha)i, \quad (2)$$

$$\frac{dr}{dt} = \gamma_1 i - (\mu_1 + \gamma_2)r,$$

With $s + i + r = 1$ 1

CONCLUSION

The research get the mathematical model of TORCH disease consist of 3 groups, that are s is susceptible group, i is an infected group and r is recover group. The model is

$$\frac{ds}{dt} = \alpha(1 - i) - s(\beta_1 i + \beta_2 + \mu_1),$$

$$\frac{di}{dt} = s(\beta_1 i + \beta_2) + \gamma_2 r - (\mu_1 + \mu_2 + \gamma_1 - \alpha)i,$$

$$\frac{dr}{dt} = \gamma_1 i - (\mu_1 + \gamma_2)r,$$

with $s + i + r = 1$ 1.

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THE DEVELOPMENT OF EDUCATION GAME AS INSTRUCTIONAL MEDIA TO FACILITATE STUDENTS' CAPABILITIES IN MATHEMATICAL PROBLEM SOLVING

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Abstract

This study aims to produce a valid educational games, practical, and able to facilitate students' mathematical problem solving ability. This study is a development research using Borg & Gall model which has been modified. The stages of research procedures performed include needs analysis, product development, validity, revision 1, limited user test, revision 2, test a large group of users, revision 3, and the final product. This research was conducted at the Junior High School 1 Singingi. Subjects were technologists and subject matter experts as validator and eighth grade junior high school 1 Singingi and the object of this study are educational games and mathematical problem solving ability of students. The data were obtained through a validation process by the validator, the practicalities of the students, and test students' mathematical problem solving ability in the form of the posttest. Data collection instrument validation in the form of sheets, sheet practicalities questionnaire and posttest about math problem-solving abilities. The data were analyzed with descriptive analysis techniques. The educational game development results have been tested with a validity rate of 84.1% (very valid) and the degree of practicality 85.42% (very practical) as well as the level of students' mathematical problem solving ability of 75.06% (moderate). From these results, it was identified that the educational game developed was very valid, very practical and can facilitate mathematical problem solving ability of students with moderate predicate.

Keywords: *Development, Educational Games, Math Problem Solving Ability.*

INTRODUCTION

Mathematics as a basic knowledge is taught for all levels of education and has many important components in its learning, one of which is problem solving, as stated by the National Council of Teachers of Mathematics (NCTM) that problem solving is an integral part of all mathematics learning, It should not be the isolated part of the mathematics program.

The ability to solve mathematical problems is very much needed by students, as most mathematics learning will be problem solving. However, based on interviews with one of the mathematics teachers at State Junior High School 1 Singingi and the tests that have been done, most students still cannot solve mathematical problems well. Students still cannot identify the elements that are known, asked, and the adequacy of the required elements of the given story. The students also have not been able to formulate mathematics' problems and apply strategies to solve problems from the story problem.

Most students think that mathematics is a difficult and tedious lesson, so they are less interested in learning that causes their low math problem solving ability. Mathematics learning held at State Junior High School 1 Singingi using the supporting books used by students in the library, teaching materials in the form of student worksheets, and has used the media in the form of power point, video, and interactive CD learning, but still cannot facilitate the students' math problem solving skills. One of the media that has not been used by teachers is educational games, which is one of the media that can facilitate student problem solving skills as stated by Moursund.

To find the solution of the problem, the researchers did observation to find what is liked by the students. The researchers found that most students really liked games, and because there were no teachers using games as learning media, the researchers took the initiative to develop educational games to help facilitate students' math problem solving skills.

Playing games are a primordial aspect of what it means to be a child and they develop within a motivating environment; therefore, not to take advantage of games as a learning resource would be to neglect an important asset. With regard to mathematics, emphasis will be given to the advantages that this teaching and learning tool provides for certain mathematical processes, such as problem-solving.

It is important to make changes in teaching process learning by developing educational games. Educational games are games that teach users to learn by developing certain concepts, an understanding that guides them to improve their abilities, and motivates them to play. According to Sadiman, one of the advantages of the game allows application on concepts or role to situations and solves real problems in society. So this study aims to develop valid and practical game education to facilitate problem-solving abilities.

METHOD

This research used research and development (R & D) method. Research and development is a process or steps to develop new products, or to improve the existing products. This research was conducted at SMP Negeri 1 Singingi for 8th grade students with purposive sampling. The study was developed using a modified Borg & Gall model (researching and gathering information, planning, developing initial product forms, initial field testing, major product revisions, primary field testing, product operating revisions, final product revisions). The procedures involved are needs analysis, product development, validity, revision 1, user-limited testing, revision 2, user group test, revision 3, and end products.

The data analysis used the qualitative and quantitative descriptive questionnaires. The descriptive qualitative analysis is used to analyse data from technology experts and mathematicians; Lecturers for the proposal, and the comments of the revised educational game. The descriptive quantitative analysis:

$$\text{Validity} = \frac{\sum \text{obtained score}}{\sum \text{score criteria}} \times 100\%$$

$$\text{Practicality} = \frac{\sum \text{obtained score}}{\sum \text{score criteria}} \times 100\%$$

The level of validity and practicality can be seen in the following table:

Table 1
Level of validity / practicality of educational games

No	Ideal Percentage (%)	Categories
1.	0-20	Not Valid/ Not Practical
2.	21-40	Less Valid / Less Practical
3.	41-60	Enough Valid/ Enough Practical
4.	61-80	Valid / Practical
5.	81-100	Very Valid / Very Practical

Source: Riduwan (2011:21)

The ability of students' mathematical problem solving can be seen from the following table:

Table 2
Level of Student Mathematical Problem Solving

No	Ability Level	Predicate
1.	80% - 100%	High
2.	60% - 79%	Middle
3.	< 60%	Low

Source: Hartono & Amir Zubaidah (2010:30)

DISCUSSION

The procedures involved: needs analysis, found that there are students with low ability to solve problems. And then, product development is used adobe flash professional cc 2015. In developing the product focuses on the purpose of planning facilitate the problem solving ability of eighth grade math students especially for problem solving circle of subject, interface make (opening, menu, exercise, keyanswer, and Score). Furthermore, validation test is done by technician, lecturer, and teacher, 1 subsequent revision, limited tester test consisting of seven people, 2nd revision, large group user test consisting of 20 eighth grade students, and revision 3. Ultimately, it is about research results using game education.

Table 3
Validation Result from Technologist of Educational Game

No	The criteria of Educational Game	Validity	Criteria
1.	Feasibility of Appearance	80,95%	Very Valid
2.	Feasibility of Presentation	83,33%	Very Valid
3.	Language	73,33%	Valid
Average		**79,2%**	**Valid**

The results of data analysis showed that this educational game displayed the feasibility of appearance of 80.95%, feasibility of presentation 83.35%, and 73.33% for language and with average of 79.2%.

Then validation results from lecturers and teachers of education games are presented below:

Table 4
Validation Results from Lecturers and Teachers of Educational Games

No.	Variable of Validity	Validation Score	Criteria
1.	Feasibility of Contents	92%	Very Valid
2.	Language	85%	Very Valid
3.	Problem Solving	90%	Very Valid
Average Score		**89%**	Very Valid

The results of data analysis showed that education *game* performed feasibility of content of 92%, language of 85%, and problem solving of 90% with average score of89%.

The test results of limiter users upon education game are presented as below.

Table 5
Test Results of Limited Users upon Education Game

No.	Variable of Validity	Score of Validity	Criteria
1.	Feasibility of Performance	97,62%	Very Practical
2.	Feasibility of Presentation	95,71%	Very Practical
Average Score		**96,67%**	**Very Practical**

From the above data, it showed that the performance feasibility is very practical or with score of 97.62%, while feasibility of presentation is 95.71% and average score is96.67%; The test results of big groups on education game is as described below:

Table 6
The test results of big groups on education game

No.	Variable of Validity	Score of Validity	Criteria
1.	Feasibility of Performance	86,83%	Very Practical
2.	Feasibility of Presentation	84%	Very Practical
Average Score		**85,42%**	**Very Practical**

The data concluded that education game is very practical in performance feasibility with the score of 86.83% and the feasibility of presentation is 84% with average percentage of85.42%;

Finally, the results of post-test of problem solving ability in mathematics is 75.1%.

CONCLUSION

1) The validity of educational games as a medium of learning to facilitate the problem solving skills of students of SMP class VIII is valid with the percentage of 79.2% for technology validity and 89% for media validity used.
2) The practicality of educational games as a medium of learning to facilitate the math skills of class VIII SMP students is very practical with 96.67% percentage for small group users and 85.42% for large group users.
3) Memory problem solving skills of junior high school students of class VIII after using the game of medium education with percentage of 75.1% and above KKM applicable in school.

4) The result of developing game education is 84.1% (very valid), and the practical level is 85.42% (very practical), students' math problem solving ability is 71.5% (enough). In conclusion the developed educational game is highly valid, very practical to facilitate solving student math problems, and categorized into enough.

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AN ANALYSIS OF STUDY UNDERSTANDING STUDENT CONCEPTTHROUGH STUDENT-SCHEDULARED DISCOVERY METHODS CLASS X SMK NEGERI 1 LUBUK BASUNG

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Abstract

A good understanding of mathematical concepts is very important for students, but today students still consider mathematics as a formula memorizing lesson without knowing the real concept. One effort to improve students' understanding of mathematical concepts is through the application of guided discovery models. This study aims to determine the ability of students' understanding of mathematical concepts through guided discovery models. One of the causes of the low understanding of student concepts is the way of teachers teach who still apply conventional learning. As a result students do not understand concepts and students can not explain the interconnectedness among the concepts. So the solution is used as an alternative in improving students' concept of understanding by teaching using guided discovery model. This research uses quantitative descriptive approach with quasi experimental method. The population of the research is the students of class X SMK, the research sample is random two classes are taken randomly which has 65 students. The first class is taught by guided discovery model while the other class is taught by conventional model. Data collected by using questionnaires, and learning test outcomes. The data obtained were analyzed by descriptive statistics and inferential statistics. The result of the research shows that the improvement of students' mathematical concept comprehension ability. Students' achievement of guided discovery models are higher than control classes that use conventional learning. Thus it can be said that guided discovery model can improve the ability of understanding mathematical concepts of vocational students. In addition, students respond positively to guided discovery models.

Keywords*: concept comprehension, guided discovery*

PRELIMINARY

Mathematics is a subject that must be taught in a vocational high school for all areas of expertise. Mathematics can train students to think critically, logically, innovatively and imaginatively, it is very necessary for vocational high school students to get a job or create their own jobs. Given the importance of the role of mathematics in human life, the government made mathematics as a compulsory subject. It aims to make the learning that can lead learners to achieve a competence that is expected, and can be useful in life as the next generation of the nation.

Because mathematics has many functions in life, to achieve it all then compiled the purpose of learning mathematics. All the objectives of mathematics learning are contained in Permendiknas No.22, 2006 whose contents are: (1) Understanding the concepts of Mathematics, explaining interconnectedness and applying concepts or algorithms, flexibly, accurately, efficiently and appropriately, in problem solving; (2)

Using reasoning in patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements; (3) Solve problems that include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained; (4) Communicating ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems; (5) Appreciate the usefulness of mathematics in life, which has a curiosity, attention, and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving.

Based on the above description can be seen the importance of mathematical learning in human life. Mathematics learning in addition to developing students' thinking skills can also shape the character and attitude of positive students. Therefore, the process of learning mathematics that implemented in school must have an impact on students' thinking ability, namely the ability to think in solving math problems and problems in everyday life.The fact that happened today, the process of learning mathematics that is implemented still can not develop students' mathematical thinking ability maximally. This can be seen from the results of student learning is low. This can be seen from the results of the National Examination of students of SMK Negeri 1 Lubuk Basung Lesson Year 2016/2017 with an average of 35.86. Based on the results obtained shows the low learning outcomes mathematics students SMK Negeri 1 Lubuk Basung.

The low learning outcome of students is caused by several factors, one of the contributing factors is the low ability of students' concept comprehension. Understanding the concept of a skill that becomes the basis for students in doing mathematics. According to Duffan and Samson (in kesumawati, 2008: 230) students have the ability to understand the concept when students are able to (1) Explain the concept or be able to re-reveal what has been communicated to it. (2) Using concepts in different situations, and (3) Developing some consequences of a concept.

When viewed from the mathematical concepts in the curriculum can be divided into three groups, namely the planting of basic concepts, conceptual understanding, and skill development (Heruman, 2007: 2). Here are the steps of learning that are emphasized on the concepts of mathematics: 1) The Basic Concept Planting, that is learning a new concept of mathematics, when students have never studied the concept. The learning of basic concept planting is a bridge that must be able to connect the concrete cognitive abilities of students with new abstract mathematical concepts. 2) Understanding Concepts, conceptual understanding consists of two meanings. First, it is a continuation of concept-planting learning in one meeting. Second, learning conceptual understanding is done at different meetings, but is still a continuation of conceptualization. 3) Fostering Skills, namely advanced learning from conceptualization and conceptual understanding. Therefore it can be said that a student has a good understanding of the concept if able to explain back the concepts that have been studied, provide an example and not an example of the concept and use the concept of problem solving.

Based on the above description, it can be seen that conceptual understanding has an important role in learning mathematics, so the concept of understanding is an ability that needs attention.

But the reality is found, the ability to understand the concept that students currently have not demonstrated the ability of understanding a good concept. The low ability of students to understand the concept of mathematics seen from the way students in solving problems given. Students have difficulties solving different problems from examples given by teachers. Students focus only on the examples teachers have given. Students still can not re-express the complete concept that has been learned, as well as using concepts in problem solving, there are still many students find difficulties in answering the questions given by the teacher, because students do not understand using the concept which is where to solve the problem.

The lack of ability to understand the mathematical concepts of students one of the causes associated with the learning process mathematics dilijakan teachers at school. Learning in schools today is still dominated by teachers as the main informers. Teachers directly provide material explanations and concepts and examples related to learning. Students are less actively involved in constructing their own knowledge to understand the concepts being studied. Students are not much involved in constructing their knowledge, just accepting the information conveyed from the teacher. Often students are not able to answer different questions from the teacher's example. This is because students only hear teacher explanations, model, and do the exercises follow the pattern given by the teacher, not because the students understand the concept. According to Shadiq (2009: 9) that the learning model as described above, can be said more emphasis to students to memorizing or memorizing (rote learning) and less or even not emphasize to students to reasoning, Problem solving or on understanding (understanding). Thus such learning will make students' activity very low, and do not allow students to think and participate actively in full. Learning done in this way also can not develop or improve the ability of high-level mathematical thinking of students.

Looking at some of the above explanations, it can be said that the learning of mathematics held in schools today still has not led to the improvement and development of high-level mathematical thinking skills of students. According Minarni (2013: 163) that to master advanced mathematics is required the ability of high-order mathematics thinking (high order thinking skills) which includes the ability of understanding, reasoning, connection and representation and problem-solving skills. If students have good high-level metaphic thinking skills, so students will also have the ability to solve problems.

Based on the above problems then we should as a teacher able to create learning that can improve students' concept of understanding so that the purpose of learning mathematics can be achieved. Because concept comprehension can be achieved when students are exposed to conditions that can elicit students' desire to practice their conceptual comprehension skills, the conditions are raised during the learning process. This means that a teacher must choose a model, approach, strategy and learning techniques that can improve students' conceptual comprehension skills.

The use of various theories and learning models in teaching becomes imperative for a teacher when doing the learning process in the classroom. The requirement is contained in Permendiknas no. 16 year 2007 regarding the standard of academic qualification and teacher competence, competence related to the use of various model or approach in teaching is pedagogic competence. One of the lessons suggested and in accordance with developments and innovations in education is discovery-based learning. Learning by invention is one way teachers can use in mathematics learning, where students are actively involved in building their own knowledge. Therefore, the authors provide solutions to one of the learning theories that can support and improve the ability of understanding the concepts of mathematics students of SMK that is with guided discovery learning model.

The guided discovery learning model is a learning model popularized by Bruner. This model requires active involvement of students in understanding concepts and principles, while teachers encourage students to have experience and experiment that allows them to find principles for themselves. Discovery in learning mathematics means the activity produces a mathematical idea, a rule, or a way of solving the problem, the mathematical idea that students first discovered is not necessarily a completely new idea, at least new to students. Ideas that are found alone will be better understood and remembered by the inventor. Therefore, the invention is used as one of the methods in learning mathematics. Bell (1981: 241) says that discovery learning can occur in very regular situations, both students and teachers follow systematic steps. The teacher guides and directs the students one step at a time by following the question-and-answer form that has been systematically organized to make the discovery. Activity steps or instructions can be set forth in the teacher work sheet. In addition, teacher intervention is also needed to arouse students' attention to the tasks that are being faced and reduce the waste of time. Bell calls this kind of learning called guided discovery learning.

According to Prasad (2011: 32) guided discovery method encourages students to think for themselves, self-study, without having to depend fully on the teacher. Meanwhile, Shadiq (2009: 12) explains that guided discovery learning is a learning where students are given a situation or problem, which then collects data, makes conjectures, trial and error, searches and finds regularity (Pattern), generalize or arrange the formula along with the general form, prove whether or not the allegation is correct. Therefore learning with guided discovery allows students to build their own knowledge through activities designed by teachers, thus making a conclusion based on students' understanding.

Learning by guided discovery method the teacher acts as a facilitator guiding students through questions that lead students to connect their knowledge with the knowledge being studied. Students are encouraged to think for themselves, analyze themselves, so they can find concepts, principles, or procedures based on teaching materials that have been provided. The teacher directs the students with the questions presented on the student worksheet to make observations, make guesses, try and formulate conclusions. Through this activity, students are expected to not directly accept the concepts and principles and procedures that have been made in the learning activities, but rather emphasized on the process of thinking, finding and finding concepts, principles and procedures of mathematics without being informed entirely. Based on the characteristics of guided discovery centered on the students and has several advantages, and supported data from previous research that shows guided discovery able to improve students 'mathematical thinking ability, then in this research will be applied guided discovery method that is predicted to improve students' mathematical concept understanding.

Thus, guided discovery learning involves maximum student and teacher activity. Students actively make discoveries and teachers provide gradual coaching and create environments that allow students to make the discovery process.

Based on the problems that have been found above, it is assumed that the guided discovery learning model can improve students' concept comprehension ability.

Therefore, the authors conducted a study using literature study method entitled "Analysis of Understanding Ability of Student Concept Through Guided Discovery Method".

METHOD

This research uses quantitative descriptive approach with quasi quasi experimental method implemented in SMK Negeri 1 Lubuk Basung class X odd semester of academic year 2017/2018. The population in this study are students of SMK Negeri 1 Lubuk Basung class X odd semester of academic year 2017/2018. Sample determination is done by random sampling. Based on the sampling technique, two classes are selected on the condition that the class is not the superior class. The selected sample is class X Accounting 1 consisting of 32 students as experiment class and X Accounting 2 consisting of 33 students as control class.

Instruments used in this study are learning devices, test instruments and non-tests. Learning tools consist of Syllabus, RPP, LKS. The test instrument is a test of the ability of understanding mathematical concepts. While the non-test instrument is a student activity observation sheet.

Data collection techniques used in this study in the form of tests, documentation, and questionnaire (questionnaire). This study used initial evaluation and final evaluation tests in the form of essays with logarithmic materials used to measure students' mathematical concepts. The data obtained is the cognitive value of mathematical concepts in the form of the final evaluation of the learning program analyzed by using descriptive statistics and inferential statistics.

Results of understanding mathematical concepts achieved by students on tests Preliminary evaluation and final evaluation test can be calculated by the following formula:

$$N = \frac{Testskor}{Maximumscore} x100$$

With N as the final value.

Then the average value of the ability of understanding the mathematical concepts can be interpreted using the table as follows:

Table 1 Interpretation of the ability to comprehend mathematical concepts

No.	**Criteria**	**Value**
1.	≥ 95,00	Specialties
2.	80,00-94,99	Very good
3.	65,00-79,99	Good
4.	55,00-64,99	Cukup
5.	40,00-54,99	Less
6.	< 40,00	Very less

(Arikunto, 2013)

In addition, the percentage level of understanding of mathematical concepts per indicator achieved By the student on the evaluation test can be calculated by the formula as following:

$$P = \frac{Testskor}{Maximumscore} x100\%$$

With P as the percentage of students' answer scores. Furthermore, the percentage of the ability to understand the mathematical concepts can be qualified as follows:

Table 2 Qualification of students' understanding of mathematical concepts

Percentage (%)	**Qualification Concept Understanding**
81-100	Very high
61-80,99	Height
41-60,99	Enough
21-40,99	Low
0-20,99	Very low

(Arikunto, 2013)

RESULTS AND DISCUSSION

The results of the initial evaluation of the ability of understanding mathematical concepts

Table 3 Frequency distribution of students' mathematical concepts on the final evaluation

Class	**Class Experiments**	**Class Control**		**Description**		
		f	**%**	**f**	**%**	
	≥ 95,00	3	9,38	1	3,03	Specialties
	80,00-94,99	12	37,50	6	18,18	Very Good
	65,00-79,99	13	40,63	10	30,30	Good
	55,00-64,99	4	12,50	8	24,24	Enough
	40,00-54,99	0	0,00	6	18,18	Less
	< 40,00	0	0,00	2	6,06	Extremely less
	Total	32	100,00	33	100,00	

Based on Table 3, it is known from 32 experimental class students who follow the learning, none of the students are in the qualification less up to very less. The highest frequency is in a special qualification, very good, and good, that is equal to 87.51%. From the data obtained, it is known that the average value of the experimental class is 76.30 and includes good qualification. While in the control class, of 33 control class students who followed the lesson, which included less qualification until very less there were 8 students or 24.24%. The highest frequency of qualification is excellent, very good, and good, that is equal to 51,51%. The average grade of the control class is 60.90 and includes enough qualification.

Table 4 Percentage of achievement of each indicator of students' mathematical concepts in the final evaluation

No.	Understanding Mathematical Concept Indicator	Experimen Class Percentage Achievement (%)	Experimen Class Qualification	Control Class Percentage Achievement (%)	Control Class Qualification
1.	Redefine a concept	94,52	Sangat tinggi	70,39	Tinggi
2.	Classify objects according to certain properties according to their concepts	96,05	Very high	89,14	Very high
3.	Provide examples and not examples	61,84	high	57,24	Enough
4.	Develop sufficient terms or conditions of a concept	55,26	Enough	48,68	Enough
5.	Using, utilizing, and selecting certain procedures or operations	57,89	Enough	57,24	Enough
6.	Presents concepts in various forms of mathematical representation	65,13	high	64,47	high
7.	Apply objects or algorithms to troubleshooting	56,58	Enough	51,32	Enough
	Average	69,61	high	62,64	high

From Table 4 it is known that the average percentage of students' mathematical concepts in the experimental class and control class are high qualifications. In addition, it can be seen also that for the percentage of achievement understanding of mathematical concepts of students experimental class higher than the control class on all indicators.

From these descriptions, it is known that mathematical learning using guided discovery models gives a positive impact both on the ability of students 'mathematical concepts and student responses. These results are in line with the opinion of Van De Walle (2008) that students' involvement in reflective thinking processes in the model of discovery Guided can influence students' understanding of mathematical concepts. Thus, it can be concluded that guided discovery models can be applied to improve students' mathematical concepts.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the research results obtained can be taken several conclusions as follows

(1) The ability to understand the mathematical concepts of students learning by using guided discovery learning models is in very high and high qualifications for each of the two indicators, while the other indicators are in sufficient qualification. While improving the ability to understand the concept of mathematics is in the qualification is being.

(2) The ability to understand the mathematical concepts of students learning using conventional learning is at a very high qualification for one indicator, high qualification for two indicators and sufficient qualification for other indicators. While improving the ability to understand the concept of mathematics is in the qualification is being.
(3) Improved ability to understand the mathematical concepts of students learning by using guided discovery learning models higher than students learning with conventional learning.
(4) Students respond positively to guided teaching learning model.

Suggestion

Based on the conclusions obtained can be put forward some suggestions as follows:
(1) Students can train and develop their thinking ability in finding their own concept on learning with guided discovery learning model.
(2) Teachers in the field of mathematics study can apply guided discovery learning model as an alternative and variation in mathematics learning to reduce students 'saturation in learning and improve students' mathematical concept understanding.
(3) For teachers of mathematics study which will implement learning by using guided discovery learning model is expected to pay attention to learning time and readiness of students.

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SOLVE OF DUAL FULLY FUZZY LINEAR SYSTEM BY USE LU FACTORIZATIONS METHOD OF THE COEFFICIENT MATRIX WITH TRAPEZOIDAL FUZZY NUMBERS

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Abstract
LU factorizations is an alternative way to solve dual fully fuzzy linear system of the $\tilde{A}\otimes\tilde{x} = \tilde{C}\otimes\tilde{x}\otimes\tilde{d}$, *and the next we make LU factorizations from the matrix* $\tilde{A}$ *and* $\tilde{C}$. *We will contract a simple algorithm for the solution of these system. Finally we will illustrate the method by solving some examples.*

***Keywords**: dual fully fuzzy, trapezoidal fuzzy number, LU Decomposition*

INTRODUCTION

The fuzzy numbers was first discussed by Luthfi A. Zadeh in 1965. Due there is the teory of fuzzy numbers, hence there is the teory of fuzzy linear system. Solve fuzzy linear system have been discussed by researchers, among others M. Friedman *et al.*, (1998). Various researchers, such as R. Ezzati *et al.,*(2012), S. Radhakrishnan *et al.,*(2014) and N. Jayan Karthik *et al.,*(2013), have further extended the problem to the fully fuzzy linear system (FFLS) of the form $\widetilde{A}x = \widetilde{b}$ where $\widetilde{A}$ is a matrix of triangular fuzzy numbers and $\widetilde{b}$ is a fuzzy vectore with triangular fuzzy numbers as its components.

Another form of fuzzy linear system $\widetilde{A}\otimes\widetilde{x}\oplus\widetilde{b} = \widetilde{C}\otimes\widetilde{x}\oplus\widetilde{d}$ is the dual fully fuzzy linear system. In particular, for real matrix $\widetilde{A}$ and $\widetilde{C}$, in fuzzy numbers in the parametric from $\widetilde{b}$ and $\widetilde{d}$, also in general. The dual fully fuzzy linear system has been discuss by Mashadi,(2010) used LU factorizations of the coefficient matrix with triangular fuzzy numbers, and then Ahmad, (2016), has been discuss dual fully fuzzy linear system of the form $\widetilde{A}\otimes\widetilde{x} = \widetilde{C}\otimes\widetilde{x}\oplus\widetilde{d}$ used ST decomposition method with trapezoidal fuzzy numbers.

In this paper, we will discuss about an alternative way to solve dual fully fuzzy linear system of the form $\widetilde{A}\otimes\widetilde{x} = \widetilde{C}\otimes\widetilde{x}\oplus\widetilde{d}$ by used LU factorizations of the coefficient matrix with trapezoidal fuzzy numbers. In the next section, we will recall some main definitions of the fuzzy numbers, dual fully fuzzy linear system, arithmetic of trapezoidal fuzzy number and LU factorizations.

LITERATURE REVIEW

2.1 Fuzzy and dual fully fuzzy linear systems

Some of the basic definitions of fuzzy numbers have been Mashadi, (2010); S. Radhakrisman, (2012); Ahmad Jafarian, (2016). We recall some definition:

Definition 2.1. Fuzzy numbers are the set of fuzzy $\tilde{u}: R \to [0,1]$ which meets the following conditions:

(I) $\underline{u}$(r) monotonic increasing in [0,1],

(II) $\overline{u}$(r) monotonic decreasing in [0,1],
(III) $\underline{u}(r) \leq \overline{u}(r), 0 \leq r \leq 1$.

Definition 2.2. The fuzzy number $\tilde{A} = (m, n, \alpha, \beta)$ is said to be trapezoid fuzzy number with membership function as follows:

$$\tilde{A} = \begin{cases} 1 - \frac{m-x}{\alpha}, & m - \alpha \leq x \leq m, \alpha > 0 \\ 1 & , m < x < n \\ 1 - \frac{x-n}{\beta}, & n \leq x \leq n + \beta, \beta > 0 \\ 0, & otherwise \end{cases}$$

Definition 2.3. A fuzzy number $\tilde{A}$ is called positive (negative), denoted by $\tilde{A} > 0$ ($\tilde{A} < 0$), if its memebership function $\mu_{\tilde{A}}(x)$ satisfies:

a. A trapezoidal fuzzy number $\widetilde{A} = (m, n, \alpha, \beta)$ is said to be non-negative trapezoidal fuzzy number if $\widetilde{A} \geq 0$ jika dan hanya jika $m - \alpha \geq 0$
b. Two fuzzy numbers $\widetilde{A} = (m, n, \alpha, \beta)$ and $\widetilde{B} = (x, y, \gamma, \delta)$ are said to be equal if only if $m = x, n = y, \alpha = \gamma, \beta = \delta$.
c. A matrix $\widetilde{A} = \tilde{a}_{ij}$ is called a fuzzy matrix,if each element of $\widetilde{A}$ is a fuzzy number. $\widetilde{A}$ will be positive if $\widetilde{A} > 0$ and will be negative if $\widetilde{A} < 0$ and will be non positive if $\widetilde{A} \leq 0$

Definition 2.4. Arithmetic of trapezoidal fuzzy number, let $\tilde{A} = (m, n, \alpha, \beta)$ and $\tilde{B} = (x, y, \gamma, \delta)$ are two trapezoidal fuzzy numbers :

- addition
  $$\widetilde{A} \oplus \widetilde{B} = (m, n, \alpha, \beta) \oplus (x, y, \gamma, \delta) = (m + x, n + y, \alpha + \gamma, \beta + \delta)$$
- subtraction
  $$-\widetilde{B} = -(x, y, \gamma, \delta) = (-y, -x, \delta, \gamma)$$
- multiplication
  for $\widetilde{A} \geq 0$ dan $\widetilde{B} \geq 0$,
  $$\widetilde{A} \otimes \widetilde{B} = (m, n, \alpha, \beta) \otimes (x, y, \gamma, \delta) = (mx, ny, m\gamma + x\alpha, y + \beta)$$

In dual fully fuzzy linear system, all enties or elements of the dual fully fuzzy linear system are fuzzy numbers, while the form of a dual fully fuzzy linear system with trapezoid membership value is:

$$\begin{cases} \tilde{a}_{11}\tilde{x}_1 + \tilde{a}_{12}\tilde{x}_2 + \cdots + \tilde{a}_{1n}\tilde{x}_n = \tilde{c}_{11}\tilde{x}_1 + \tilde{c}_{12}\tilde{x}_2 + \cdots + \tilde{c}_{1n}\tilde{x}_n + \tilde{d}_1 \\ \tilde{a}_{21}\tilde{x}_1 + \tilde{a}_{22}\tilde{x}_2 + \cdots + \tilde{a}_{2n}\tilde{x}_n = \tilde{c}_{21}\tilde{x}_1 + \tilde{c}_{22}\tilde{x}_2 + \cdots + \tilde{c}_{2n}\tilde{x}_n + \tilde{d}_2 \\ \vdots \qquad\qquad\qquad\qquad \vdots \\ \tilde{a}_{n1}\tilde{x}_1 + \tilde{a}_{n2}\tilde{x}_2 + \cdots + \tilde{a}_{nn}\tilde{x}_n = \tilde{c}_{n1}\tilde{x}_1 + \tilde{c}_{n2}\tilde{x}_2 + \cdots + \tilde{c}_{nn}\tilde{x}_n + \tilde{d}_n \end{cases}$$

We can be written into the form:

$$\tilde{A} \otimes \tilde{x} = \tilde{C} \otimes \tilde{x} \oplus \tilde{d}$$

We can define that $\tilde{A} = (\tilde{a}_{ij})$, $\tilde{C} = (\tilde{c}_{ij})$, $1 \leq i, j \leq n$ is a fuzzy matrix of size $n \times n$ and $\tilde{d}, \tilde{x}$ adis a fuzzy vector. This system is called the dual fully fuzzy linear System equations. Then, we define also that $\tilde{A}, \tilde{C}, \tilde{d}, \tilde{x}$ are positive.

The following will be given the definition of the invers multiplication of the matrix, as discussed by H. Anton,(1998).

Definisi 2.5 The matrix $n \times n$ is said to be singular if there is a matrix B such that $AB = BA = I$. The matrix B is said to be the invers multiplication of the matrix A.

2.2 LU Factorisation

Factorization is basically forming a square matrix as the multiplication of two triangular matrix and the upper triangular matrix. Systematically can be written in the $A = LU$.

Suppose that $\tilde{A} = (A, M, N, W)$ and $\tilde{C} = (C, P, Q, R)$ so that the LU factorization of the matrix $\tilde{A}$ and $\tilde{C}$ is as follows:

$$(L_1, 0,0,0) \otimes (U_1, U, U_3, U_4) = \tilde{A} = (A, M, N, W) \quad (2.1)$$

And,

$$(L_1{}^o, 0,0,0) \otimes (U_1{}^o, U_2{}^o, U_3{}^o, U_4{}^o) = (C, P, Q, R) \quad (2.2)$$

METHOD AND DESIGN

In this paper we will discuss about determining the solve dual fully fuzzy linear system use LU factorizations of the coefficient matixwith trapezoid fuzzy number, while the steps are:

1. Give a dual fully fuzzy linear system
   $\tilde{a}_{11}\tilde{x}_1 + \tilde{a}_{12}\tilde{x}_2 + \cdots + \tilde{a}_{1n}\tilde{x}_n = \tilde{c}_{11}\tilde{x}_1 + \tilde{c}_{12}\tilde{x}_2 + \cdots + \tilde{c}_{1n}\tilde{x}_n + \tilde{d}_1$
   $\tilde{a}_{21}\tilde{x}_1 + \tilde{a}_{22}\tilde{x}_2 + \cdots + \tilde{a}_{2n}\tilde{x}_n = \tilde{c}_{21}\tilde{x}_1 + \tilde{c}_{22}\tilde{x}_2 + \cdots + \tilde{c}_{2n}\tilde{x}_n + \tilde{d}_2$
2. Change the system of equations in point 1 into the form of matrix A and C:
   $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, \ C = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & cc_{22} \end{bmatrix}$
3. Next determine the LU factorization A and C
4. Then after obtain L and U from matrix C, then we can put U_2, U_3, U_4 obtain from multiplication invers matrix $L(L^{-1})$ with the entries in the system of the equation.
5. Based on the steps above, its will be obtained a simple formula to determine the solution x, y, z, w.

FINDING AND DISCUSSION

1. Solving dual fully fuzzy linear system

Suppose there is a dual fully fuzzy linear system equations as follows:

$$\begin{cases} \tilde{a}_{11}\tilde{x}_1 + \tilde{a}_{12}\tilde{x}_2 + \cdots + \tilde{a}_{1n}\tilde{x}_n = \tilde{c}_{11}\tilde{x}_1 + \tilde{c}_{12}\tilde{x}_2 + \cdots + \tilde{c}_{1n}\tilde{x}_n + \tilde{d}_1 \\ \tilde{a}_{21}\tilde{x}_1 + \tilde{a}_{22}\tilde{x}_2 + \cdots + \tilde{a}_{2n}\tilde{x}_n = \tilde{c}_{21}\tilde{x}_1 + \tilde{c}_{22}\tilde{x}_2 + \cdots + \tilde{c}_{2n}\tilde{x}_n + \tilde{d}_2 \\ \qquad \vdots \qquad\qquad\qquad\qquad \vdots \\ \tilde{a}_{n1}\tilde{x}_1 + \tilde{a}_{n2}\tilde{x}_2 + \cdots + \tilde{a}_{nn}\tilde{x}_n = \tilde{c}_{n1}\tilde{x}_1 + \tilde{c}_{n2}\tilde{x}_2 + \cdots + \tilde{c}_{nn}\tilde{x}_n + \tilde{d}_n \end{cases} \quad (3.1)$$

We can written equation 3.1 into,

$$\tilde{A} \otimes \tilde{x} = \tilde{C} \otimes \tilde{x} \oplus \tilde{d} \quad (3.2)$$

We will define $\tilde{A} = (A, M, N, W)$, $\tilde{C} = (C, P, Q, R)$, $\tilde{x} = (x, y, z, w)$, and $\tilde{d} = (f_1, f_2, f_3, f_4)$, so the general from of a dual fully fuzzy linear system can be describe as follow:

$$(A, M, N, W) \otimes (x, y, z, w) = (C, P, Q, R) \otimes (x, y, z, w) \oplus (f_1, f_2, f_3, f_4) \quad (3.3)$$

Then, for the left equation in equation (4.2) then it can be written

- $L_1U_1 = A, \Rightarrow U_1 = L_1{}^{-1}A$
- $L_1U_2 = M, \Rightarrow U_2 = L_1{}^{-1}M$
- $L_1U_3 = N, \Rightarrow U_3 = L_1{}^{-1}N$ (3.4)
- $L_1U_4 = W, \Rightarrow U_4 = L_1{}^{-1}W$

And for the right equation in equation (4.2) is:

- $L_1{}^oU_1{}^o = \text{C}, \Rightarrow (L_1{}^o)^{-1}C$

- $L_1{}^oU_2{}^o = \mathrm{P}, \Longrightarrow (L_1{}^o)^{-1}P$ (3.5)
- $L_1{}^oU_3{}^o = \mathrm{Q}, \Longrightarrow (L_1{}^o)^{-1}Q$
- $L_1{}^oU_4{}^o = \mathrm{R}, \Longrightarrow (L_1{}^o)^{-1}R$

Based on equation 2.1 and 2.2 then equation 4.3 can be written into the following from:

$$(L_1U_1, L_1U_2, L_1U_3, L_1U_4)\otimes(x,y,z,w) = (L_1{}^oU_1{}^o, L_1{}^oU_2{}^o, L_1{}^oU_3{}^o, L_1{}^oU_4{}^o)\otimes(x,y,z,w)\oplus(f_1,f_2,f_3,f_4) \quad (3.6)$$

Based on the rules of multiplication on fuzzy trapezium, then equation 3.6 can be described as follows:

$$(L_1U_1)x, (L_1U_2)y, [(L_1U_1)z + (L_1U_3)x], [(L_1U_2)w + (L_1U_4)y] = (L_1{}^oU_1{}^o)x, (L_1{}^oU_2{}^o)y, [(L_1{}^oU_1{}^o)z + (L_1{}^oU_3{}^o)x], [(L_1{}^oU_2{}^o)w + (L_1{}^oU_4{}^o)y] \oplus(f_1,f_2,f_3,f_4)$$

And then,

$$(L_1U_1)x, (L_1U_2)y, [(L_1U_1)z + (L_1U_3)x], [(L_1U_2)w + (L_1U_4)y] = (L_1{}^oU_1{}^o)x + f_1, (L_1{}^oU_2{}^o)y + f_2, [(L_1{}^oU_1{}^o)z + (L_1{}^oU_3{}^o)x] + f_3, [(L_1{}^oU_2{}^o)w + (L_1{}^oU_4{}^o)y] + f_4$$

The description of the above equation can be written as follows:

$$x = (L_1U_1 - L_1{}^oU_1{}^o)^{-1}f_1$$
$$y = (L_1U_2 - L_1{}^oU_2{}^o)^{-1}f_2 \quad (3.7)$$
$$z = (L_1U_1 - L_1{}^oU_1{}^o)^{-1}[f_3 - (L_1U_3 - L_1{}^oU_3{}^o)x]$$
$$w = (L_1U_2 - L_1{}^oU_2{}^o)^{-1}[f_4 - (L_1U_3 - L_1{}^oU_3{}^o)y]$$

2. Computational example

Solve the following dual fully fuzzy linear system:

$$\begin{cases} (6,9,5,6)\otimes\tilde{x}_1\oplus(7,8,3,3)\otimes\tilde{x}_2 = (3,3,3,4)\otimes\tilde{x}_1\oplus(3,2,2,1)\otimes\tilde{x}_2\oplus(27,66,54,70) \\ (9,4,7,8)\otimes\tilde{x}_1\oplus(14,6,9,5)\otimes\tilde{x}_2 = (8,2,1,6)\otimes\tilde{x}_1\oplus(10,1,7,1)\otimes\tilde{x}_2\oplus(17,37,58,55) \end{cases}$$

Solution: first we obtain LU decompositions for matrices A and C as follows:

$$A = \begin{bmatrix} 6 & 7 \\ 9 & 14 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1.5 & 1 \end{bmatrix}\begin{bmatrix} 6 & 7 \\ 0 & 3.5 \end{bmatrix} = L_1U_1$$
$$C = \begin{bmatrix} 3 & 3 \\ 8 & 10 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 2.66 & 1 \end{bmatrix}\begin{bmatrix} 3 & 3 \\ 0 & 2 \end{bmatrix} = L_1{}^oU_1{}^o$$

So, we will find matrices U_1, U_2, U_3, U_4 as follows

$$U_2 = L_1{}^{-1}M = \begin{bmatrix} 1 & 0 \\ 1.5 & 1 \end{bmatrix}\begin{bmatrix} 9 & 8 \\ 4 & 6 \end{bmatrix} = \begin{bmatrix} 9 & 8 \\ -9.5 & -6 \end{bmatrix}$$
$$U_3 = L_1{}^{-1}N = \begin{bmatrix} 1 & 0 \\ 1.5 & 1 \end{bmatrix}\begin{bmatrix} 5 & 3 \\ 7 & 9 \end{bmatrix} = \begin{bmatrix} 5 & 3 \\ -0.5 & 4.5 \end{bmatrix}$$
$$U_4 = L_1{}^{-1}W = \begin{bmatrix} 1 & 0 \\ 1.5 & 1 \end{bmatrix}\begin{bmatrix} 6 & 3 \\ 8 & 5 \end{bmatrix} = \begin{bmatrix} 6 & 3 \\ -1 & 0.5 \end{bmatrix}$$
$$U_2{}^o = (L_1{}^o)^{-1}P = \begin{bmatrix} 1 & 0 \\ -2.66 & 1 \end{bmatrix}\begin{bmatrix} 3 & 2 \\ 2 & 1 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ -5.98 & -4.32 \end{bmatrix}$$
$$U_3{}^o = (L_1{}^o)^{-1}Q = \begin{bmatrix} 1 & 0 \\ -2.66 & 1 \end{bmatrix}\begin{bmatrix} 3 & 2 \\ 1 & 7 \end{bmatrix} = \begin{bmatrix} 3 & 2 \\ -6.98 & 1.68 \end{bmatrix}$$
$$U_4{}^o = (L_1{}^o)^{-1}R = \begin{bmatrix} 1 & 0 \\ -2.66 & 1 \end{bmatrix}\begin{bmatrix} 4 & 1 \\ 6 & 1 \end{bmatrix} = \begin{bmatrix} 4 & 1 \\ -4.64 & -1.66 \end{bmatrix}$$

The next we will obtain $\tilde{f}_1, \tilde{f}_2, \tilde{f}_3, \tilde{f}_4$

$$\tilde{f} = \begin{bmatrix} 27 & 66 & 54 & 70 \\ 17 & 37 & 58 & 55 \end{bmatrix}$$

Since

$$\tilde{f}_1 = \begin{bmatrix} 27 \\ 17 \end{bmatrix}, \tilde{f}_2 = \begin{bmatrix} 66 \\ 37 \end{bmatrix}, \tilde{f}_3 = \begin{bmatrix} 54 \\ 58 \end{bmatrix}, \tilde{f}_4 = \begin{bmatrix} 70 \\ 55 \end{bmatrix}$$

Therefore , by equation (3.7) conclude that

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = (L_1U_1 - L_1{}^oU_1{}^o)^{-1}f_1 = \begin{bmatrix} 5.080 \\ 2.939 \end{bmatrix}$$

$$y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = (L_1U_2 - L_1{}^oU_2{}^o)^{-1}f_2 = \begin{bmatrix} 6 \\ 4.99 \end{bmatrix}$$

$$z = \begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = (L_1U_1 - L_1{}^oU_1{}^o)^{-1}[f_3 - (L_1U_3 - L_1{}^oU_3{}^o)x] = \begin{bmatrix} 9.75 \\ 2.908 \end{bmatrix}$$

$$w = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = (L_1U_2 - L_1{}^oU_2{}^o)^{-1}[f_4 - (L_1U_3 - L_1{}^oU_3{}^o)y] = \begin{bmatrix} 5.65 \\ 2.34 \end{bmatrix}$$

Hence we have the solution $\tilde{x}_1 = (x_1, y_1, z_1, w_1) = (5.080, 6, 9.75, 5.65)$ dan
$\tilde{x}_2 = (x_2, y_2, z_2, w_2) = (2.939, 4.99, 2.908, 2.34)$

CONCLUSION

In this paper solution of dual fully fuzzy linear system $\widetilde{A} \otimes \tilde{x} = \widetilde{C} \otimes \tilde{x} \oplus \tilde{d}$ where $\widetilde{A}$ and $\widetilde{C}$ are the coefficient matrices of trapezoidal numbers while $\tilde{d}$ is fuzzy vector obtained by LU factorizations method of the coefficient matrix with substituting in the original equation.

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STUDENTS WORKSHEET BASED ON MODEL ELICITING ACTIVITIES (MEAS) IN DEVELOPING MEDIA INSTRUCTIONAL TO IMPROVE SENIOR HIGH SCHOOL STUDENTS' CREATIVE THINKING AT PADANG

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Abstract

Math is a study that helps students to improve the way of thinking critically, logically, and creatively. Creative thinking is a process used to create a new idea. This point shows that the students' creative thinking skill is very important to be noted by the teacher. In fact, the students' creative thinking skill is still relatively in a low level. This matter can be seen from the students learning achievement when a test requires creative thinking skill is delivered, they find some problems to solve the test. The lack of an appropriate teaching material used and the use of inappropriate teaching material for students needs, resulting the students' creative thinking skill become lower. Further, a learning condition that facilitates the students to improve their creative thinking skill is needed. Besides, it needs media instruction in the form of students' worksheet which able to guide the students to develop and enhance their creative thinking. One of the learning approaches that hopes to improve students creativity is Model Eliciting Activities (MEAs). MEAsis a learning approach that focuses on students' activity in creating solutions for the real problem given by applying mathematical procedures to form a math model. One of MEAs characteristics is helping the students to improve high mathematical thinking skill, in which creative thinking is one of high level thinking skills. MEAsis hoped in helping the students to explore their creativity in designing math model from a real problem and motivate them to participate actively during learning process.

Key words:*Material instructional development, students' worksheet, Model Eliciting Activities, and creative thinking skill*

THEORY OF STUDY

A. Approach Of Model Eliciting Activities (MEAs)

There are two approaches in mathematics learning. According to Roy Killen in Wulandari (2016: 13), there are two main approaches in mathematics learning: (1) teacher-centered approaches and (2) student-centered approaches. A teacher-centered approach is a condition where students are more passive in learning and learning are generally taught directly so as to lack the creation of students' mathematical thinking processes. While the student-centered approach is a condition in which the student is more dominantly active than the teacher and the learning raises the students' mathematical thinking activities. In this approach, the teacher acts as a facilitator who must be able to arouse students' interest in a learning material and provide a variety of approaches to the way of learning so that the students (who are different) get the most appropriate learning method for them. One of the student-centered approaches is the Model Eliciting Activities (MEAs) approach.

Model Eliciting Activities (MEAs) is a student-centered learning approach, where students are facilitated to develop a mathematical model of a given problem. This approach emerged in the mid-1970s. According to Chamberlin (2005: 4) "Model Eliciting Activities (MEAs) are mathematical problems created by mathematics educators, and are used by mathematics instructors. These group activities require students to develop a mathematical model that is a conceptual allowing students to make sense of certain kinds of mathematical experiences. This means that MEAs are mathematical problems created by mathematics educators, professors and students throughout the United States and Australia, for use by mathematics teachers. This group activity requires students to develop a mathematical model that is a conceptual system so that students gain a variety of mathematical experiences. In line with that, according to Hamilton (2008: 4) that "MEAs is the problem that simulates real-world situations, that small team of 3-5 students work to solve over one or two class periods. The crucial problem-solving iteration of an MEAs is to express, test and revise models that will solve the problem ". Meaning MEAs are a problem based on real-world situations, with small teams of 3-5 students working to solve more than one or two problems. The most important problem-solving process of the MEAs is to present, test and review the model that will solve a problem. This shows that MEAs is a learning approach where students in small groups are given real problems and students are expected to solve the problem based on the understanding of the concept they have learned. Then Hidayat (2014: 58) also states that the learning of MEAs is a learning approach based on realistic issues, work and discussion in small groups, then presents a model. So learning with the MEAs approach is a student-centered learning where students are facilitated to be more active in solving realistic mathematical problems and then creating mathematical models that are suitable to solve them

Some characteristics of the MEAs approach are: (1) real life based learning and able to develop students' mathematical thinking, (2) students are more active in thinking about solving problems, and (3) students are expected to be able to construct mathematical models. According to Stohlmann (2013: 61) that MEAs are well-structured, realistic MEAs mathematics allows students to innovate, synthesize, communicate, and adapt gradually in developing a mathematical model that is a problem solution. Accordingly, according to Hidayat (2014: 58), one of the characteristics of the MEAs approach is to give students opportunities to take control of their own learning with process guidance. Another characteristic of these MEAs is real life based learning and able to develop students' mathematical thinking. Wulandari (2016: 14) states that the learning approach of MEAs is a learning based on students' real life and fosters student thinking because students create their own models to solve mathematical problems. Permana in Siregar (2013: 529) also states that in this MEAs approach, the model created does not have to be a new concept in mathematics. The important thing is genuine student thought and is something new for students.

Based on the above description, the Model Eliciting Activities (MEAs) approach is a more student-centered approach where activities undertaken begin with the presentation of real-life problems around students, then from the problem students form a model of mathematical problem solving, then students Trying to find a solution from the model as a solution. So with the application of MEAs approach, students are expected to be more active in learning so that later expected to improve students' mathematical thinking ability.

B. Principles of Approach Model Eliciting Activities (MEAs)

There are six principles in developing the Model Eliciting Activities (MEAs) approach. Chamberlin and Moon (2005: 39) states that the six principles are: (1) *Model Construction Principle, (2) The Reality Principle, (3) The Self-Assessment Principle, (4) The Construct Documentation Principle, (5) The Construct Shareability and Reusability Principle, dan (6) The Effective Prototype Principle.*Here's an explanation of the six principles of the Model Eliciting Activities approach (MEAs) by Chamberlin and Moon (2005: 39-40) is :

1. *Model Construction Principle*
   This principle contains the construction, modification, extension and review of a model. Creating models requires deep understanding of issues that help students shape their thinking.
2. *The Reality Principle*
   This principle states that the problems in the MEAs should be relevant and reflect the real-life situation as well as build students' knowledge and experience. Because such modeling activities not only serve to improve mathematical problem solving skills, but also help students connect their mathematical learning with disciplines, scientific, social, and environmental.
3. *The Self-Assessment Principle* (Prinsippenilaiandiri)
   Students should be able to measure the feasibility and usefulness of solutions without the help of teachers. This principle occurs when groups are looking for the right answer. Usually students rarely find the best answer on the first attempt and students will make the next attempt to get a more accurate answer.
4. *The Construct Documentation Principle*
   This principle expressed students' own thinking during work and their thought processes should be documented in the solution. The demands of the solution documentation involve writing techniques.
5. *The Construct Shareability and Reusability Principle*
   This principle explains the model that the student produces should apply to the problem in other related situations. In creating a model, students must think that the resulting model will be able to be used and re-modified in the face of similar problems. To be able to assess whether the model is genelralisasi, usually the teacher to discuss among students to discuss the advantages and beliefs of the resulting model.
6. *The Effective Prototype Principle*
   This principle states that the resulting model must be easily understood by others. This principle helps students learn that creative solutions applied to math problems are very useful and can be used generally.

C. Stages of Approach Model Eliciting Activities (MEAs)

There are several stages in the Model Eliciting Activities (MEAs) approach. Chamberlin (2005: 5) explains that , "MEAs is implemented in several steps. First, the teacher reads a simulated newspaper article that develops a context for students. Subsequently, the students respond to readiness questions that are based on the article. Next, the teacher reads the problem statement with the students and makes sure each group understands what is being asked and students subsequently attempt to solve the problem. After creating multiple iterations of the solution and revising when necessary, students present their models to the class. Typically, teachers provide about one hour to solve the problem,but certain MEAs may require up to two periods of class time to complete*"*. This means that the MEAs are implemented in several steps: (1) the teacher reads a newspaper article developing a context for the student, (2) the student is ready with the questions based on the article, (3) the teacher reads the problem statement with the students and ensures that each the group understands what is being asked, (4) the students attempt to solve the problem, (5) the students present their mathematical model after discussing and reviewing the solution, and (6) the teacher typically prepares an hour to solve the problem but some of the MEAs Requires more than two classroom meetings to complete.

Corresponding to Chamberlin's point, NG Kit Ee Dawn in Ayuningtyas (2015: 26) adds that in the MEAs there are several steps: the teacher for 20 minutes explains the definition of modeling in mathematics; then, students are asked to work in groups consisting of 4- 5 students to create a mathematical model, the students were given 1 hour to complete the modeling assignment, the students were asked to present the results of their discussion in the form of the poster, each group appoint one of their group members for presentation, during the presentation each group wrote Their opinions are based on 3 criteria, namely representation, validity, and application using reflection paper. The paper contains 3 questions related to the task being presented is:

a. Representation
   That is how well the model is made to solve the problem?
b. Validity
   Can you give suggestions to improve the model?
c. Application
   That is the model that has been made used in other mathematical concepts?

MEAs is an approach that develops students' ability in constructing a model, therefore the learning stage also prefers the cooperation of the students in the group in building the mathematical model to solve a problem. Stage learning model eliciting activities (MEAs) in learning in this study as follows:

a. Students are divided into groups of 3-4 students each group.
b. Each group is given Teaching Materials that have been compiled based on the learning principles of the Model Eliciting Activities approach and demanded the work using the MEA approach.
c. Students solve problems given by group discussion (group discussion). While teachers around the class guided the students in mengorksi mistakes he made.
d. Representatives of students from several groups (groups with different answers) presented the results of their work in front of the class.
e. During the presentation process, each group was given a reflection sheet to assess the results of other group presentations.
f. Students or other groups are given the opportunity to respond to the results of their friend's presentation (class discussion). In this case the teacher becomes the facilitator of the course of the discussion and gives questions about the student's work.

Completing the MEAs stage, Ritonga (2017: 44) states in detail the activities of teachers and students during the application of the Model Eliciting Activities

Table 1. Steps of Model Eliciting Activities (MEA)

Teachers'Activity	Students'Activity
Step1:Defining	
Teacher gives a problem as early as the introduction for students to understand and then be able to resolve the problems well	Students observe, understand and define the problems
Step2:Descriptioning	
Teachers give problems related to contextual Issues	Students build knowledge based on existing problems with their knowledge
Step3:Manipulating	
Teachers monitor and guide the students to be able to model the problem in mathematical form for the purpose of demonstrating	Students create a mathematical model based on Issues that have been given
Step4: Translating	
Teachers lead studentsto solve problems	Students solve problems based on a mathematical model that they have made at the stage of manipulation
Step5:VerificatingandPredicting	
Teachers urge students to check back answers to problems that have diselesikan so that there are no mistakes.	Students check their work one by one
Step6:Presenting	
Teachers lead students to present their work andthendiscussedtogetherwithotherstudents	Students present the work that has been completed

D. The Ability of Mathematical Creative Thinking

Mathematics learning at the level of primary and secondary education is conducted in an environment that facilitates students to be creative. The ability to think creatively is the ability to create, develop, implement something new from what has been previously obtained. This is in accordance with the opinion of Coleman and Hammen (Sukmadinata, 2004a) in Istianah (2013: 46) that "Creative thinking is a mental activity to enhance the originality and the grasping of insight in generating." The ability to think creatively with regard to the ability to produce or develop something new, something unusual that is different from the ideas generated by most people.

According to the Regulation of the Minister of Education and Culture No. 103 of 2014 in Amalia (2015: 1-2) that learning in primary and secondary education is conducted based on activities with (1) interactive and inspirational characteristics; (2) fun, challenging, and motivating learners to participate actively; (3) contextual and collaborative; (4) provide sufficient space for the initiative, creativity, and independence of learners; And (5) in accordance with the talents, interests, abilities, and physical and psychological development of learners. This shows that the ability to think creatively is the ability that is expected to grow and develop in the process of learning mathematics.

According to Nuriadin (2013: 68-69) that the ability to think creatively is a person's ability to find new ideas or ideas in solving problems by using previous experience they already have. Basically the experts have the same view of the characteristics of creative thinking ability. However, to provide clarity and understanding of the appropriate, the researchers will describe four common characteristics that will be an indicator that will be used in this study, among others:

1. Smooth thinking skills (Fluency)
   The fluency skills here are included in sparking many ideas, answers, problem solving or questions. Provide many ways or suggestions to do things and always think of more than one answer. This may be one of the most powerful indicators of creative thinking, because the more ideas, the more likely it is to gain a significant idea.
2. Flexibility thinking skills (Flexibility)
   Flexibility is the ability to overcome mental obstacles, changing the approach to a problem. Not stuck by assuming rules or conditions that can not be applied to a problem. So that students can apply a concept or a principle in different ways.
3. Original thinking skills (Originality)
   The category of originality refers to the uniqueness of any given response. Originality is represented by an unusual, unique and rare response that can create unusual combinations of parts or elements.
4. Detailed Skills (Elaboration)
   The ability to describe a particular object, idea, or situation in detail so that it becomes something more interesting.

Based on the descriptions mentioned above, it can be formulated that the notion of creative thinking ability is a new thinking ability acquired by experiment and characterized by the skills of smooth thinking, flexible, original, and elaboration.

In line with the above opinion, Balka (Mann, 2005) in Sumarmo (2012: 23) states that the ability of mathematical creative thinking includes the ability to think convergent and divergent thinking, broken down into: a) the ability to formulate mathematical hypotheses related to cause and effect a situation of mathematical problems, b) the ability to determine patterns in situations of mathematical problems; c) the ability to break the deadlock of the mind by proposing new solutions of mathematical problems; d) the ability to express unusual mathematical ideas and to evaluate the consequences; e) the ability to identify missing information from a given problem, and f) the ability to break down common issues into more specific sub-issues.

The essence of the Model Eliciting Activities (MEAs) is the student's creativity in learning. Chamberlin (2005: 42) states that the core of the Model Eliciting Activities (MEAs) is the student's creativity in learning. Chamberlin (2005: 42) states that "Creativity is at the heart of MEAs, and it plays a signif- icant role in student success in mathematics. With respect to math solutions, diversity in thinking is a process that is paramount to the successful development of models (Lesh & Doerr, 2003). However, the significance of creativity in school mathematics may be minimized because it is not formally assessed on standardized tests, which purport to thoroughly measure mathematical learning. MEAs can act to fill the assessment void created by standardized tests, and they provide performance-based assessment of the ability of students to generate creative mathematical ideas in response to a well-structured problem." This means that creativity is the main thing that is attached to MEAs and plays an important role in student success in mathematics. With the Meas, the students' ability to generate creative mathematical ideas in response to well structured problems.

E. Student Work Sheet (LKPD)

Student Work Sheet (LKPD) can also be called Student Activity Sheet (LKS). In this worksheet the students are led to find the concept of understanding of a subject matter especially mathematics. In this worksheet contains instructions and how to work with problems that are done together. In the process of learning mathematics, teachers are expected to create good learning conditions in achieving the competence of learning. Wafiqoh (2016: 40) states that the Government Regulation no. 19 of 2005 article 20, suggests that teachers are expected to develop teaching materials as one of the learning resources that are part of the Lesson Plan (RPP) through the development of teacher teaching materials will be more helpful in achieving competence.

Prastowo (2014) in Wafiqoh (2016: 41) states that LKS is a printed material in the form of sheets of paper containing the materials, summary, and instruction on the implementation of learning tasks that must be done students, both theoretical and practical that refers to the competence The basis for which students have to achieve and their use depends on other teaching materials. Types of LKS: (1) LKS of discovery, this type of LKS contains what the student should do; (2) LKS that is applicative-integrative (helping students to apply and integrate the concepts that have been found; (3) LKS guides (functioning as study guides); (4) strengthening LKS (functioning as strengthening); (5) (Serves as a practicum manual) The LKS developed in this study is the guiding LKS.

Completing the above, Prastowo (2011) in Loviana (2016: 35) LKPD consists of six main elements and formats in the preparation. The following LKPD elements are viewed from the structure and format:

Table 2. LKPD from its structure and format

No	LKPD structure	LKPD Format
1	Title	Title
2	Study instructions	Basic Competencies to be achieved
3	Basic Competence or material	Settlement Time
4	Support information	Equipment / Materials to complete the task
5	Tasks or steps	Brief information
6	Assessment	Work steps
7	-	The task to do
8	-	Report to do

F. Learning Device Relationships in the form of Student Work Sheets (LKPD) Based on Model Eliciting Activities (MEAs) with the Ability of Creative Mathematical Thinking

Mathematics learning activities in schools at this time tend to be oriented only on the task of routine tasks and not a real problem. Students tend to be assigned tasks from printed books or LKPD books that come from printing that provide less real problems that are expected to improve students' creative thinking ability. This results in the ability of students to tend to be more memorable than the understanding of the material or on the high level of ability. In fact, learning in the classroom should be able to facilitate students to develop other abilities.

One of the abilities in mathematics is the ability to think creatively mathematically. The ability of mathematical creative thinking is the ability of a person to find new ideas or ideas in solving problems by using the previous experience they already have. Therefore, a learning environment is needed that is able to facilitate students to develop the ability of mathematical creative thinking.

One effort to create a learning environment that is able to facilitate students to cultivate the ability of mathematical creative thinking is to apply a student-centered learning. One of the student-centered approaches is the Model Eliciting Activities (MEAs) approach. Model Eliciting Activities (MEAs) is a student-centered learning approach, where students are facilitated to develop a mathematical model of a given problem. Wulandari (2016: 14) states that the learning approach of MEAs is a learning based on students' real life and fosters student thinking because students create their own models to solve mathematical problems. Permana in Siregar (2013: 529) also states that in this MEAs approach, the model created does not have to be a new concept in mathematics. The important thing is genuine student thought and is something new for students.

The essence of the Model Eliciting Activities (MEAs) is the student's creativity in learning. Chamberlin (2005: 42) states that the core of the Model Eliciting Activities (MEAs) is the student's creativity in learning. Chamberlin (2005: 42) states that "Creativity is at the heart of MEAs, and it plays a signif- icant role in student success in mathematics. With respect to math solutions, diversity in thinking is a process that is paramount to the successful development of models (Lesh & Doerr, 2003). However, the significance of creativity in school mathematics may be minimized because it is not formally assessed on standardized tests, which purport to thoroughly measure mathematical learning. MEAs can act to fill the assessment void created by standardized tests, and they provide performance-based assessment of the ability of students to generate creative mathematical ideas in response to a well-structured problem." This means that creativity is the main thing that is attached to MEAs and plays an important role in student success in mathematics. With the Meas, students' ability to generate creative mathematical ideas in their own models to solve mathematical problems in response to well-structured problems. So hopefully this makes the creative thinking ability of students will develop.

In order for the Model Eliciting Activities (MEAs) approach to run optimally, a learning device is needed to support the implementation of phases in the Model Eliciting Activities (MEAs) approach, one of which is by using the Student Working Sheet (LKPD). Loviana (2016: 39) states that LKPD that can be called LKS is a teaching material that contains the tasks accompanied by instructions and steps in completing the task so as to make students build knowledge and understanding independently and develop the expected ability. The developed LKPD proposes contextual issues with drawings and writings.

LKPD developed in the form of specially designed LKPD. The LKPD created has components corresponding to the phases in the Model Eliciting Activities (MEAs) approach. So with the LKPD-based approach Eliciting Activities Model (MEAs), is expected to help students in menumbuhkembangkan mathematical creative thinking ability.

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IMPROVING COMMUNICATION ABILITY AND PROBLEM SOLVING MATHEMATICAL BY USING PACE MODEL LEARNING REVIEWED FROM DIFFERENCE LEARNING STYLE AND SELF-EFFICACY

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Abstract

This research is motivated by not yet optimal communication ability and problem solving of mathematical learners. Communication skills and mathematical problem solving are very important to develop because communication skills and problem-solving abilities is one of the goals of mathematics learning that must be mastered by learners. The ability of mathematical communication is the ability of learners in communicating ideas or ideas about mathematics material that learners learn, for example in the form of concepts, formulas, or strategies to solve a problem through oral, written, and demonstrate it and visualize it visually. Mathematical problem solving ability is the ability of learners in finding solutions of difficulties that require creativity, understanding, and thinking. Mathematical communication and problem solving skills of learners can be developed together in the learning process of mathematics through the model of learning PACE. The PACE learning model is a conceptual framework of learning based on constructivism that has stages/phases: Project, Activity, Cooperative Learning, and Exercise using the LKPD in the process Learning. In addition to applying PACE learning model, other factors that must be considered by educators are factors of learners themselves such as differences in learning styles and self-efficacy because the two factors have an influence in learning mathematics. PACE learning model is good to be applied in learning mathematics, because it can improve communication ability and solving mathematical problem of learners.

Keyword:*Communication Skill, Problem Solving, PACE Model Learning, Learning Style, Self-Efficacy*

PRELIMINARY

Mathematics as one of the basic science that has developed rapidly both the material and its usefulness in real life. According to Yulianto and Sugeng (2017) mathematics is a universal science that underlies the development of technology. Soedjadi (2000) stated that the form of mathematics subjects in primary and secondary education is school mathematics. School mathematics is the elements or parts of mathematics that are selected oriented to the interests of education and interests to master and utilize the technology in the future.

The purpose of mathematics education in schools emphasizes learners in order to have skills related to mathematics, other subjects or problems related to real life; Ability in mathematics as a means of communication; The ability to use mathematics as a viable means of reasoning in any situation such as logical thinking, critical thinking, systematic thinking, honesty, discipline in looking at, and problem solving.

National Council of Teachers of Mathematics (NCTM) in 2000 established five mathematical standards that students must possess, namely problem solving, communication, connection, reasoning, And the ability of representation.

Communication skills and mathematical problem solving is very important to develop because it is one of the goals of learning mathematics that must be mastered by learners. In addition, communication skills and mathematical problem solving are also related to each other. The ability of mathematical communication is the ability of learners in communicating ideas or ideas about mathematical material that includes the use of the skills of writing, listening, reviewing, interpreting, and evaluating the ideas, symbols, terms, and mathematical information observed through the process of listening, presenting, and discussion. A learner acquires the concept in learning then when it happens the transformation of mathematical information from the source to the learner. Learners respond by interpretation of the information, resulting in mathematical communication.

Indicator of the ability of learners that can be developed in making mathematical communication by Sumarmo (2014) is a situation or problem into the form of language, symbol, idea, or mathematical model (can be in the form of drawings, diagrams, graphs, or mathematical expressions); Explaining ideas, situations, and mathematical relations in the form of plain language; Listening to discussions, and writing about mathematics; Understand a mathematical representation; Reveals a math expression in its own language. Therefore, through communication owned so that students will have the ability to solve problems in mathematics.

In applying mathematical concepts to solve problems related to mathematics, such as solving stories, solving non-routine problems, applying mathematics in everyday life or other circumstances, and proving or creating or testing conjectures. This ability is not only used in the process of learning mathematics in school but can be applied in real life so that math will feel more meaningful.

Indicator of the ability of learners that can be developed in solving problems according to Polya (1973) there are some activities or stages that can be done by learners that is understanding the problem (understanding the problem), devising a plan, carrying out the plan (carrying out the plan), And do the check back (looking back). Therefore, in a given problem, learners identify what is known, what is asked, and what elements to solve the problem so it is easy to complete

One way to cultivate communication skills and solving mathematical problems of learners according to Yulianto and Sugeng (2017) is to train students to work on problems related to these skills. Therefore, the condition of the learning of mathematics needs to be a model of PACE learning, because the PACE learning model is a conceptual framework of learning based on constructivism that has phase: Project, Activity, Cooperative Learning and Exercise using the Student Working Sheet (LKPD) in the learning process.

In addition to applying PACE learning model, other factors that must be considered by educators are factors of learners themselves such as differences in learning styles and self-efficacy because the two factors have an influence in learning mathematics. This can be proved from the results of the study Alfian Saat Abdillah (2017) with the conclusion of learners with visual learning style, aural, read/write, and kinesthetic have different ways of understanding information. Then the results of research Sri Hastuti Noer (2012) also concluded that a positive self-efficacy will affect a person in making decisions and actions that will do. A person will tend to run something when he feels competent and confident; Will determine how far the effort is doing; How long he endures when he gets into trouble. Zimmerman (2000) reveals that one's self-efficacy varies from one field to another. Therefore, the greater the self-efficacy of a person, the greater his effort, persistence, and flexibility. Bandura (1997) reveals that self-efficacy is defined as a person's judgment about his or her ability to achieve desired or determined performance levels, which will influence the subsequent action in which he seeks to assess the degree, the authenticity, and strength of all activities and contexts

Based on the above description, the researcher assumes that PACE learning model can improve communication ability and solve the mathematical problems of learners in terms of learning style differences and self-efficacy. Therefore, the researchers conducted a study using literature study method entitled "Improving Communication Ability and Problem Solving Mathematical by Using PACE Learning Model Learning Reviewed from Differences Learning Styles and Self-Efficacy".

RESEARCH METHODS

This research is literature study. Nazir (2003: 27) explains as that the technique of collecting data by conducting a study of books, literature, records, and reports relating to problems solved. In this study, researchers can collect information relating to the background of research, theories that underlie the problem to be studied, reference materials relevant to the problem or topic to be researched and the results of previous similar research. In addition, literature study also deepens and adds to the researcher's knowledge in terms of theory and research methodology.

DISCUSSION

The importance of communication and mathematical problem solving to be developed in mathematics learning is not in line with the results achieved and causes the quality of mathematics education to be not maximal. The purpose of mathematics education that has not been achieved optimally, especially in communication and problem solving of mathematics of course there is cause. According to Ruseffendi (2006) in mathematics learning there are ten factors that influence the success of learners, the readiness of learners, the talents of learners, the willingness of learners, the interests of learners, the model of presentation of the material, personal and educational attitudes, learning atmosphere, competence of educators and outside conditions . When viewed the learning process, according to Sanjaya (2010) the low quality of education due to less learning process encourages learners to develop thinking skills because learners are more directed to the ability to memorize information, so that learning becomes meaningless.

Based on the 2013 curriculum that has begun to be implemented in schools, educators are given more flexibility in developing competency standards and basic competencies to be considered by educators to change the views of learning approaches directed to develop the potential and ability of learners. Ability to be developed is the ability to solve problems, communication, understanding, reasoning, and mathematical connections.

Communication skills and mathematical problem solving of learners will be seen through the indicators and for the assessment of communication skills and problem solving learners can be done as well as possible not only indicators of communication skills and solving mathematical problems are required but also require scoring rubric. The scoring rubric for mathematical communication ability can be seen in Table 1. While the mathematical problem solving ability can be seen in Table 2.

Table 1. Matrix of Mathematical Communication Skill

No	Criteria	Score
1.	Students are able to solve the problem completely and logically that is the final answer of the student is correct, the student is able to write down his mathematical idea in solving the problem clearly and coherently using the concept correctly and using the strategy and the correct and complete completion steps.	4
2.	Students are able to solve problems in a logical but incomplete way, that is, the final answer of the student is correct, the student is able to solve the mathematical idea in solving the problem clearly, using the concept correctly, and using the correct settlement strategy, but there are some finishes that are not written down.	3
3.	Students are able to solve the problem completely and logically that students are not appropriate in using the strategy of completion and concept or there is a mistake in the calculation, but able to complete the mathematical idea in solving the problem completely.	2
4.	Students are not able to solve the problem completely and logically that is the solving of the students using the wrong steps and strategies, not coherently, resulting in a wrong solution or not even get the final answer.	1
5.	No communication (no answer)	0

Tabel 2. Matrix of Mathematical Problem Solving Skill

Score	Understanding the Problem	Preparing the Settlement Plan	Carry out the Settlement	Summing up Answers
0	Not knowing and unable to elaborate the elements contained in the problem	No settlement plan	There is no carrying out the solution	There is no conclusion
1	Lack of knowing and detailing the elements contained in the issues discussed	There is a resolution plan but it does not fit the problem	Already carrying out the settlement is not in accordance with the settlement plan and the results are not true	There is a conclusion but not in accordance with the original problem
2	Knowing the elements that exist but not clearly specified Already carrying out the settlement in accordance with the settlement plan but the result is not correct	There is a settlement plan but it is less appropriate with the problem	Already carrying out the settlement in accordance with the settlement plan but the result is not correct	There are conclusions but less suitable with the original problem
3	Identify and detail the elements contained in the problem clearly	There are settlement plans and according to the problem	Already carrying out the settlement in accordance with the settlement plan and the correct result	There is a conclusion and according to the original problem
	Max Score = 3	**Max Score = 3**	**Max Score = 3**	**Max Score = 3**

Source: Sumarmo (2003)

According to Lee (in Andri Suryana, 2013) learners taught by the PACE Model are much more actively involved through group work and class discussions. The PACE model is based on the principles of: (1) prioritizing the construction of its own knowledge through guidance, (2) practice and feedback is an essential element in maintaining new concepts, and (3) prioritizing active learning in solving a problem. The PACE Learning Model was developed by Lee (1999) which stands for Project, Activity, Cooperative Learning and Exercise.

The project (project) by Laviatan (in Andri Suryana, 2008) is an innovative form of learning that emphasizes complex activities with the goal of solving problems based on inquiry activities.

Andri Suryana (2013) suggests that Activity (activity) in the PACE model aims to introduce learners to new information or concepts. This is done by assigning tasks in the form of Worksheet Worksheet (LKT) which is one form of the Student Work Sheet (LKPD) to study the material. The role as a guide learners in learning the material and working on problems. Through LKT, learners are given the opportunity to find their own concepts to be studied.

Cooperative Learning (cooperative learning) in PACE model according to Andri Suryana (2013) implemented in class. In these lessons, learners work in groups and should discuss solutions to problems in the Discussion Worksheet (LKD). LKD is a form of Student Work Sheet (LKPD) to study material other than LKT. Through LKD, learners have the opportunity to present the findings obtained during the discussion. During the discussion, the exchange of information is complementary so that learners have a correct understanding of a concept.

Andri Suryana (2013) suggests that Exercise (exercise) in the PACE Model aims to reinforce concepts that have been constructed at the stage of activity and cooperative learning in the form of problem solving. This exercise is given to the students in the form of additional tasks in order to control the material better.

The PACE Model learning steps are as follows:

1. Educators divide learners into groups of 3 to 4 people with a heterogeneous level of ability.
2. At the activity stage, the teacher checks the child's work sheet (LKT) whether it is done at home or not before the lesson. Furthermore, educators ask learners about the concepts to be discussed in order to improve conceptual understanding and provide guidance in case of misconceptions.
3. At the cooperative learning stage, the educator provides LKD (Discussion Worksheet) to each group related to the material discussed. This is a continuation of the LKT and has a higher level of difficulty. At this stage, learners have the opportunity to present the findings obtained at the time of discussion in order to exchange information so as to establish a correct understanding of a concept.
4. At the training stage, the educator provides an additional task to reinforce concepts that have been constructed at the stage of activity and cooperative learning in the form of problem solving.
5. At the project stage, the educator assigns the project task to the students who are working in group form. Learners can choose their own topics that are considered interesting in accordance with the material. They are asked to find solutions / solutions to the problems they choose. They are required to make reports of projects that are worked on and collected at specific times according to the agreement between the educator and the learner.

Furthermore, if learners are aware that the learning process is important, and if learners see that the outcomes of the learning process will bring progress to themselves, it is likely that they will seriously follow the learning process by applying the PACE learning model and the learner will have the ability Communication and good mathematical problem solving so that he will get good mathematics learning results in accordance with the objectives of learning mathematics to be achieved.

Based on the results of Indah Setyo Wardhani (2015) study that the PACE learning model is good to be applied in mathematics learning, because it can foster creative thinking act mathematically. Then, the result of Jajo Firman Raharjo (2015) research that 1) Learning mastery using scientific approach of PACE model in developing algebraic thinking ability and student learning independence in algebra structure course, 2) Learning using scientific approach PACE model is effective in developing algebraic thinking ability and Student learning independence in the course of algebra structure and 3) Activity, student's independence influence on students' algebra thinking ability on learning by using scientific approach of PACE model of algebra structure course.

Andri Suryana (2014) also stated in his research that the PACE Model is important to apply in mathematics teaching, because it can improve mathematical representation skills. That is, PACE learning model is important to be applied in learning mathematics, because it can improve the skills of mathematical representation. Then the results of research Andri Suryana (2013) that PACE learning model is important to apply in learning mathematics, because it can improve the ability to prove mathematically.

In addition, the research results of Andri Suryana (2013) that PACE learning model is important to be applied in mathematics learning, because it can make students far actively involved in learning so as to improve Advanced Mathematical Thinking. Then, in research Andri Suryana (2013) also concluded that the PACE learning model is important to apply, because it can improve the ability of mathematical creative thinking.

CONCLUSION

Based on the discussion that has been presented and some previous research results, it can be concluded that communication skills and mathematical problem solving can be developed together through the model of learning PACE because PACE learning model is based on principles that prioritize the construction of knowledge itself through guidance, practice and Feedback is an important element in maintaining new concepts, and prioritizing active learning in solving a problem. That is, PACE learning model is good to be applied in learning mathematics because it can improve communication ability and solving mathematical problem of learners.

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OPEN ENDED APPROACHES TO IMPROVING STUDENTS' MATHEMATICAL CONNECTIONS ABILITIES

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Abstract

This study is based on the low ability of students' mathematical connections. This study aims to discuss a suitable approach used to improve the ability of mathematical connections of students at the level of junior high is still low. Mathematical connection is one of the abilities that became the purpose of learning mathematics. Mathematical connections occur between mathematics with mathematics itself or mathematics with outside mathematics. Previous studies have shown that one of the causes of low mathematical connection ability is that the learning that has been done is still centered on the teacher and in solving the mathematical problem consists of only one answer. Students are not trained in developing mathematical connection capabilities. Students are less adept at connecting between concepts. One effort that can be used as an alternative to improve the ability of mathematical connections of students is the Open Ended approach. The research method used is literature study that is by collecting data about Open Ended approach to mathematical connection ability from various sources such as relevant research, books, internet, journals, other relevant sources. After studying the literature by citing data from various sources it is suspected that the Open Ended approach can improve the ability of mathematical connections of students at the level of junior high school (SMP) class VII. With the increased ability of mathematical connections of learners, then learning will be more meaningful.

Keywords: *Open Ended Approaches, Mathematical Connection ability*

PRELIMINARY

Mathematics has an important role in education because it is the basic knowledge required by students to support their learning success in higher education. Mathematics is taught in educational institutions, both at elementary, junior high, high school and college level. But there are still many students who find it difficult to learn math.

According to NCTM (2000) the mathematics curriculum is viewed as a collection of a number of topics, so the teaching of the results of calculations from a problem solving in mathematics tends to be considered separate. In PERMENDIKNAS RI No. 20 Year 2007 stated that one of the goals of learning mathematics is to explain between concepts. With connections, students only need to recognize the relevant general principles of some knowledge. When mathematical ideas are connected daily to the experience both inside and outside the school, students will be aware of the usefulness and benefits of mathematics. As recommended by NCTM (2000: 29) the Process Standards Problem Solving, Reasoning and Proof, Comunication, Conections, and Representation, Highlight ways of acsquiring and using content knowledge. Thus, connections are the five standard processes that NCTM emphasizes. Similarly curriculum standards in China in 2006 for primary and secondary schools also emphasize the importance of mathematical connections in the form of mathematical applications, the connection between mathematics with real life and mathematical removal with other lessons (http://www.apecneted.org).

The connection capability of each students is still low. It can be seen from the result of research conducted by Sugiman (2008) which revealed that "the average percentage of mastery for every aspect of connection is an interconnection of mathematics topics 63%, among math topics 41%, mathematics with other lessons 56%, and mathematics with life 55% ". From these result seen that the percentage of connection mathematical between topics the mathematical still low. During this math learning is only teacher-centered, it is seen from the students who imitate what is conveyed by the teacher. This causes in solving math problems students focus more on the answers taught by the teacher or just focused on one step answer and when presented another problem then students will be confused and difficulty. Students also seem to have difficulty in connecting the material they learn with the pre-orders they have mastered. The concepts that have been studied do not last long in the memory of students, consequently their mathematical connection capabilities have not been optimal. The ability of mathematical connections is important but students who master mathematical concepts are not smart in mathematics. Thus the mathematical connection ability of students needs to be trained in school.

The habit of building conceptual understanding through procedural connections provides an opportunity for students to use, rewrite, and rediscover the necessary new procedures. To achieve this ability, students should be given the opportunity to observe, and arrange relationships between mathematical topics. According to Muhammad (2016) the most important from of connections and relationships among various structures in mathematics. In mathematics learning, teacher do not need to help students to examine the different and diversity of structures in mathematics, but need to be aware of the connection of various structures in mathematics.

To implement the learning done by teacher to improve the ability of mathematical connections of students is to choose the appropriate learning approach and oriented to the competence of learners, especially the ability of mathematical connections. From this learning approach, it is expected to provide flexibility for students to apply ideas in solving problems so as to improve the ability of mathematical connections of participants. One alternatif mathematical learning that can meet these expectations is open ended approach. Based Handayani (2014) research, open ended approach can improve students' mathematical connection ability.

The open ended approach as one of the approaches in learning mathematics is an approach that uses open problems. Using open issues allows students to develop their paradigms according to the interests and abilities of their students. Open problem is a problem that has been formulated to have answers in many ways or many correct answers. According to Shimada and Becker (Murni, 2013: 97) an open-ended approach is a learning approach that gives a problem that has a method or there are several ways to solve the problem. An open ended approach can provide learners with the opportunity to gain knowledge or experience in finding problems, knowing, and solving problems with several techniques. Other then, according to Ninomiya (2015) an open problem or incomplete problem was formulated to have some correct answer and asked to focus on different methods, ways, or approaches to get the correct answer.

In the learning of mathematics through an open ended approach, students are asked to develop different methods and ways of getting the right answer. From the answer of students can be seen the various possible ways of answer getting the right answer. From the answer of students can be seen the various possible ways of answering and perhaps with different outcomes (Nur Anwar, 2015). So that with various answers in the end have the possibility will encourage learners to be trained to make connections topic in mathematics.

Based on the above description it is suspected that the open ended approach can improve the ability of mathematical connections. Therefore, the authors conducted a study using literature study method entitled "Open Ended Approach To Improve Students' Mathematical Connection Ability".

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. These data sources contain: The ability of a mathematical connection and an Open Ended Approach. These sources are obtained from journals, books, research report articles and internet sites.

RESULTS AND DISCUSSION

The ability of important mathematical connections is owned by students so that they are able to connect the material between one material with another material. As explained by Bruner and Kenney (1963), in Bell (1978: 143-144), put forward the theorem in the process of learning mathematics (Theorems on Learning Mathematics). The two authors formulated four theorems in mathematics learning: (1) construction theorem that looked at the importance of representational roles related to mathematical concepts, principles and rules, (2) the notation theorem in which representation would become simpler when using symbols, (3) theorem of contrast and variation which sees the need for contrasting and diverse situations, and (4) theorem of connectivity. The five theorems work simultaneously in every process of learning mathematics.

In mathematics learning, one material may be a prerequisite for another, or one that is necessary to explain the other. Therefore, if the connection ability of students is good then their understanding of mathematics learning will be more profound and durable, and broaden the knowledge of students knowledge. Students can understand the mathematical concepts they are learning because they have imprinted the prelates relating to everyday life. So with the increased ability of mathematical connections of students, then learning becomes more meaningful.

The linkage between concepts or principles in mathematics plays an important role in learning mathematics. With that knowledge then students understand mathematics more thoroughly and more deeply. In addition to memorizing a concept is also getting a little so that learning math becomes more easy and efficient.

According to NCTM (2000) the math connection can be divided into three aspects of the connection group, namely:

1. Aspects of connections between mathematical topics
   This aspect can help learners connect mathematical concepts to solve a situation of mathematical problems.

Example: to calculate the remainder of the polynomial $f(x) = 3x^3 - 2x^2 + x - 5$ by$(x - 1)$then the settlement step can be done through the process of algebra (substitution) or through the process chart (stacking, Horner).

2. Aspects of connection with other disciplines.
   This aspect shows that mathematics as a discipline, in addition can be useful for the development of other disciplines, can also be useful to solve a problem related to other fields of study.
   Example: to solve problems related to parabolic motion in the field of physics studies, ie calculate the furthest distance from a stone thrown by a child with a certain initial velocity and elevation angle. This problem is concerned with the concept of double corners in trigonometry in mathematics.
3. Aspects of connections with real-world learners/connections with everyday life. This aspect shows that mathematics can be useful for solving a problem in everyday life.
   Example: to solve problems related to social arithmetic, for example calculate and determine the profit or loss of a sale and purchase transactions.

Through the three aspects of mathematical connections above and for example, learners will be more aware that mathematical concepts are interconnected and they will also understand the importance of math to solve everyday problems both in school and out of school.

NCTM (2000: 64) describes the indicators of mathematical connections, among others:

1) Recognize and use relationships between ideas in mathematics
2) Understanding the interrelationship of mathematical ideas and forming ideas with each other to produce a comprehensive relationship
3) Recognize and apply mathematics into the external and mathematical environment

According to Sumarmo (2006) Indicators for mathematical connections ability of learners include:

a) Recognize the equivalent relationship representation of the same concept.
b) Recognize the relationship of a single representation procedure to an equivalent representation procedure
c) Using and assessing the connection of several mathematical topics and interrelationships between mathematical topics and interconnectedness outside mathematics
d) Using mathematics in everyday life

One of the approaches that some research has referred to as improving students' mathematical connection capability is learning with Open Ended approach. The open ended approach was developed in Japan since the 1970s. According to Huda (2014: 278) Open-ended learning (OEL) is a learning process in which individual and student goals and desires are developed and achieved openly. The open ended approach can build interactive activities between students and math courses with the aim of attracting learners to answer the problem to any strategy. The most impotant thing in open ended question is the possibility and freedom for students to use some of the methods they think are best at solving the question, the meaning of open ended is suggested to continue grow in understanding the problem.

In preparing open questions it is better if the question is based on the level of thinking in Mathematics. Sanders (in Murni, 2013: 98) Understanding level is divided into two categories: Translation and Interpretation. Interpretation is a skill of students to find the relationship between fact, concept, principe, rule, and generalization.

Mathematical learning through an open-ended approach according to Shoimin (2014: 110) is a learning that uses open-ended problems and begins by providing open issues to students. Learning activities should bring students in answering the problem in many ways and possibly also many correct answers that invite the intellectual potential and experience of learners in the process of finding something new. According to Nohda (in Munroe, 2015: 97) the open-ended approach is a flexible and centered-on method of students who have recently gained popularity in the field of mathematics education. Here students who work individually or in groups, are expected to apply their own unique methodology to solve existing problems.

According to Huda (2014: 280) the steps teachers need to take in Open-Ended learning are:

a) Facing students on open problems by emphasizing how learners arrive at a solution
b) Guiding learners to find patterns in constructing their own problems
c) Allowing students to solve problems with various solutions and answers
d) Ask students to present their findings.

A distinctive feature of the Open Ended approach is the diversity of settlement methods. With the characteristics of the approach, the Open Ended approach gives the freedom of thinking to students to find answers in solving a problem. Students are also expected to better understand a topic and its relevance to other topics either in math or other subjects and in everyday life. In addition, because of its open nature, students will feel challenged in math lessons. Through presentations and discussions on some alternatives, this approach makes the students aware of the various methods of settlement. In the end the math skills of students to solve math problems can increase. This can help students to make creative math connections and make students more appreciative of the diversity of thinking during the process of completion. Thus will appear the integration between students with mathematics (Suherman, 2003). Other than, according to Sri (2015) learners who are able to connect the mahematical idea that students will understand mathematics because it can see the relationship between the topic in mathematics, with other mathematical contexts, and with the experience of everyday life.

From the above description it is seen that the Open Ended approach can foster the mathematical connections of students, because this approach does not require learners to memorize facts, but encourages learners to construct knowledge in their own minds. In this approach, students are taught to solve problems, find something useful for themselves, and wrestle with ideas. In addition, students are able to make mathematical connections with mathematics (inter-topic), other lessons or problems related to real life.

CONCLUSIONS AND SUGGESTIONS

The Open Ended Approach is an approach by giving students an open problem and giving their students freedom in solving problems with various correct resolution steps or correct answers. In solving mathematical problems used various connections of knowledge that has been previously owned. So with this Open Ended approach can improve the ability of mathematical connections of students.

The following is an indicator of mathematical connection capability according to NCTM (2000: 64) to be used in this study:

1) Recognize and use relationships between ideas in mathematics
2) Understanding the interrelationship of mathematical ideas and forming ideas one with the other so as to produce a comprehensive linkage
3) Recognize and apply mathematics into and outside the mathematical environment

Based on literature studies that have been done, the authors suggest: 1) For teachers or educators who want to improve the ability of mathematical connections of students, Open Ended approach is one alternative that can be applied to learners. 2) For the next writer who wants to write about Open Ended Finishing it is advisable to examine how to improve students' mathematical abilities by using the Open Ended approach at other levels, such as high school or vocational school.

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IMPROVEMENT OF MATHEMATICAL PROBLEM SOLVING ABILITYOF LEARNERS BY USING GUIDED DISCOVERY

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Abstract

This study aims to discuss the problem solving ability of mathematical learners using guided discovery. Problem solving skills are important in mathematics, learners are asked to solve math problems that are not routine by using the correct settlement steps. Discovery learning is a mental process in assimilating the concepts and principles within its cognitive structure to construct new knowledge. Guided discovery in question is that learners find the concept through the guidance and direction of the teacher. Guided discovery gives learners the opportunity to explore experiences they already have. Guided discovery can enable learners to learn creatively in dealing with various problem solving. The method used in this study is a study of literature study by collecting materials on developing problem-solving skills by using guided invention from various sources such as relevant research, books, and others. After conducting literature studies by citing data from various sources it is suspected that guided discovery can improve students' mathematical problem solving abilities.

Keywords: *Guided Discovery, Problem Solving Abilities*

INTRODUCTION

Mathematics is one of the things that can't be avoided from learning, either in formal learning, or in practical everyday. So the importance of mathematics so that the learning of mathematics has developed and adapted to the needs of the times. There are two visions of mathematics learning, namely: (1) directing mathematics learning to understanding concepts that are then needed to solve problems and other sciences; and (2) directing to a broader future of mathematical problematic, systematic, critical , careful, objective and open. Such capability is indispensable in the face of an ever-changing future (Sumarno in Bani, 2011).

As for the expected objectives of mathematical learning by the National Council of Teachers of Mathematics (NCTM), NCTM (2000) sets out the five mathematical standards that learners must possess: problem solving skills, communication skills, connection capabilities, reasoning skills and representational capabilities . Based on the description, the problem-solving capabilities are contained in NCTM's standard capabilities. That is, this ability is an important ability developed and owned learners.

The importance of the proposed solution Branca (1980), he argued that the problem-solving ability is the heart of mathematics. Problem-solving skills are of considerable concern in education, particularly in mathematics learning. This is seen in the purpose of learning mathematics, ie learners are expected to solve various problems given. Problem solving skills are the main outcome of a learning process. Learners should be able to solve math problems related to the real world.

Nitko & Brookhart (2011: 22) that"*Problem solving revers to the kind of thinking required when reaching A goal is not automatic and student must use one of more higher order thinking processes to do it*". Each learner will encounter problems when they want to reach a particular goal but not automatically and learners must use one or more high-level thinking to complete.

Although the problem-solving ability is very important in the learning attitudes of mathematics teaching, but based on the results of literature studies conducted by analyzing previous studies of learners, found that problem-solving ability is still low. This is obtained from the results of research that has been done by Sherly Ardila Fitri (2016), learners are not familiar with the form of problems related to problem-solving ability, this is seen from the percentage of questions given to learners. Problem solving problems are not directly illustrated completion, but require specific strategies to find a solution. Many learners are still unfamiliar with problem solving problems. Learners can determine what is known and asked from the problem, but sometimes learners difficult to understand the information implied from the problem.

The low ability of problem solving of mathematical learners is caused by several factors, one of them is the less innovative teacher in choosing the model, the method, the approach, the strategy and the learning technique which can increase the students' desire in solving the math problem. As revealed by Tiara Fikriani (2016) in his research that the learning model used in learning that tends to be monotonous and less involving learners actively in learning, where learning centered on the teacher while learners only memorize the information that has been given.

Based on the above problems then we should as an educator able to create learning that can improve the problem solving ability of learners so that the purpose of learning mathematics can be achieved. Improving problem solving skills can be achieved when learners are confronted with conditions that can elicit the learner's desire to practice their problem-solving abilities, the condition is raised during the learning process. This means that a teacher must choose theories, models, methods, approaches, strategies and learning techniques that can improve the problem solving skills of learners.

In order for learning to run well that can condition learners active in learning mathematics. The creativity needed by a teacher in creating Henningsen and Stein's learning methods in Effendi (2012) suggests that in order to improve students' mathematical abilities, learning must be an environment where learners are able to be actively involved in useful mathematical activities. Therefore, in the literature study is given solution one of the learning method that can improve the problem solving ability of mathematical learners that is guided discovery.

The invention is that learners find the concept through the guidance and direction of the teacher because in general most learners need a basic concept to determine something. In the guided discovery the teacher acts as a facilitator who guides the learner.

Based on the problems mentioned above, it is suspected that guided invention can improve students' mathematical problem solving abilities.

METHODS

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic of discussion raised in the study. This research is about improving problem solving skills and guided discovery.

RESULTS AND DISCUSSION

Solution is a process done to solve problems, while problems are challenging questions and can not be solved (solved) by routine procedures that are known. So that problem solving is one of the learning objectives that are very important especially in teaching and learning activities in mathematics. So the ability to solve the problem is a capability that the learners have in the process to solve a problem. Through problem-solving skills, learners can practice in solving non-routine math problems.

In solving the problem of problem-solving abilities should be done with several stages as follows (Fadjar, 2009: 4).

1) Understand the problem
2) Choosing a settlement strategy
3) Implement strategy
4) Check the truth of the answer

In learning mathematics, there are some indicators, according to (Sumarmo, 2010: 5) some indicators of problem solving ability in learning mathematics are: a) Identify the elements that are known, questioned, and the adequacy of the necessary elements. b) Formulate mathematical problems or develop mathematical models. c) Implement strategies to solve various problems. d) Explain or interpret the results according to the problem. e) Use mathematics meaningfully.

According to Jerome Bruner (Cooney, Davis: 1975,138) in Markaban (2006: 10) that discovery is a process, a way of approaching problems rather than a product or item of knowledge. Accordingly, according to Permendiknas number 58 (2014: 359) said that guided discovery is a learning process in which not presented a concept in final form, but learners are required to organize their own way of learning in finding the concept. From the quotation it can be concluded that in learning activities not the result so/ value expected, but how the process in learning so as to produce the final form.

Steps that must be taken by the teacher in determining the method of guided discovery according to Markaban (2006: 16) as follows.

a) Formulate problems to be provided to learners with sufficient data.
b) The formulation of the problem should be clear.
c) From the data provided by the teacher, the learners prepare, process, organize, and analyze the data.
d) Learners prepare conjectures (forecasts) from the results of the analysis it does.
e) When deemed necessary, the conjecture that the student has made is examined by the teacher.
f) If it has been obtained certainty about the truth of the conjecture, then the verbalization of conjecture should be submitted also to the learners to arrange it.
g) After learners find what they are looking for, the teacher should provide additional exercises or questions to check whether the findings are true.

Learning by using guided invention provides opportunities for learners to improve their mathematical problem-solving skills. Based on the above description and supported by some relevant previous research, it is expected that the problem solving ability of learners can be increased by using guided discovery.

CONCLUSION

Mathematical learning with guided discovery can improve problem solving skills through learners in solving non-routine problems with teacher guidance in the learning process. In the learning activity is not the finished result / value expected, but how the process in learning so as to produce the final form.

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THE IMPROVEMENT THE ABILITY OF MATHEMATICAL REASONING USING METHOD OF GUIDED DISCOVERY

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Abstract

This study aims to discuss the appropriate alternative theory used to improve the ability of students' mathematical reasoning at the level of junior high school (SMP) is still low. One of the factors that lead to low reasoning of learners is the theory of learning that teachers use less train students desire in improving the reasoning of mathematics. As for an alternative theory that is used to improve students' mathematical reasoning ability in this writing is guided discovery method. Guided discovery method is a way of delivering mathematical topics in such a way that in the learning process allows learners to find their own patterns or mathematical structures through past learning experience and can not be separated from the supervision and guidance of teachers. The method used in this study is a study of literature study by collecting data about guided penemuman methods to the ability of mathematical reasoning from various sources such as relevant research, books, etc. After conducting literature studies by citing data from various sources it is suspected that the theory of guided discovery methods can improve the ability of students' mathematical reasoning in junior high school level (SMP).

Keywords*: Guided Discovery, Mtatematic reasoning ability*

PRELIMINARY

Mathematics is an important tool for improving intellectual skills and skills. Mathematics is also a science that has a big role in the development of modern technology. Seeing the importance of mathematics, mathematics lessons are taught to students from elementary school to college, Cockroft in Risnawati (2008: 12) states that "Mathematics needs to be taught to learners because it is always used in all aspects of life, all fields of study require skills Mathematics that is appropriate, is a powerful means of communication, short and clear. In addition, mathematics can also be used to present information in a variety of ways, improve logical thinking, precision and spatial awareness and provide satisfaction to challenging problem solving. "

Because mathematics has many functions in life including for junior high school students and to achieve all that then compiled the purpose of mathematics lesson in junior high school which content has similarities with the purpose of learning mathematics at high school and vocational high school level. All the objectives of mathematics learning are contained in Wardhani (2005: 8) states that the objectives of the mathematics course are to enable learners to have the ability: [1] to understand mathematical concepts, to explain interconnectedness between concepts and apply concepts or algorithms, flexibly, accurately, efficiently, and Right in problem solving, [2] using reasoning in nature patterns, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements, [3] solving problems that include the ability to understand problems, designing models and interpreting solutions obtained, [4] communicating ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems, and [5] having an appreciative attitude to the usefulness of mathematics in life, which has a curiosity, attention, and interest in learning mathematics, And confident in problem solving.

From the purpose of learning mathematics above one important part is the ability of students' mathematical reasoning. As expressed by Wardhani (2005: 23) reasoning is a process or activity of thinking to draw conclusions or make a true new statement based on a statement that has been proven.

Although the ability of mathematical reasoning is very important in teaching and learning activities of mathematics, but based on the results of literature studies that have been done by the author by analyzing the previous studies of junior high school students, found that the ability of junior high school students' reasoning is still low. this is obtained from the results of research that has been done by Febrivanny (2014), namely that the percentage of mastery of learners in the first cycle only 28% ie in the category of "less". In cycle II the percentage of mastery of learners has increased ie 68% ie in the category of "good". The low ability of students 'mathematical reasoning is caused by several factors, one of which is the less innovative teachers in choosing the models, methods, approaches, strategies and learning techniques that can improve students' mathematical reasoning ability.

The use of various theories and learning models in teaching becomes imperative for a teacher when doing the learning process in the classroom. The requirement is contained in Permendiknas no 16 of 2007 regarding the standard of academic qualification and teacher competence, the competence related to the use of various models or approach in teaching is pedagogic competence. Therefore, in this literature study the author provides a solution of one theory of learning that can support and improve the ability of junior high school students' reasoning reasoning is the method of guided discovery.

Guided discovery method is defined as a teaching procedure that emphasizes individual teaching, in which the method of discovery is a component of educational practice that includes teaching methods that promote active learning, process-oriented, self-directed and self-seeking (Suryosubroto 2002: 11). Teachers act as facilitators who help learners to use the ideas, concepts, and skills they have learned to discover new knowledge. So learning with guided discovery methods is an attempt to find concepts or procedures or principles under the guidance of teachers. Thus, guided discovery learning involves the activities of teachers and learners to the fullest. In accordance with the opinion of Badjeber (Purwatiningsih, 2013: 61) which states that with this guided discovery model learners become more active in following the learning process both in doing LKPD given by the teacher and discussion between groups, and can construct their understanding independently.

Based on the problems mentioned above it is suspected that guided discovery methods can improve students' math reasoning ability. And therefore the authors conducted a study using a literature study method entitled "Improving the Mathematical Reasoning Skills of Learners Using the Guided Discovery Method".

METHOD

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. The data sources contain: mathematical reasoning and guided discovery methods. These sources are derived from relevant research, books, articles and internet sites.

RESULTS AND DISCUSSION

Based on the results of literature studies that have been done, the method is a regular way that has been thought through in depth for use in achieving a goal. Zuhdan Kun Prasetyo, et al in Suprihatiningrum (2013: 245) argues that discovery learning is divided into two, namely free discovery and guided discovery. Encyclopedia Education research (Suryosubroto, 2002: 4) defines that discovery is a unique strategy that teachers can provide in a variety of ways, including teaching investigating skills and problem solving as a tool for learners to achieve educational goals. Discovery is a process by which learners to achieve educational goals. Discovery is a process by which learners are able to assimilate a concept or principle. From the above opinion, it can be concluded that guided discovery method is a method where in the process of teaching and learning teachers allow learners to find their own information that already exists in the process of mental activity through the exchange of opinions and try to solve problems themselves.

In guided discovery the teacher can find instructions, directives, statements to LKPD so that to arrive at a conclusion about a subject taught on LKPD given by the teacher depends on the ability of the learners and the topics to be studied and clarified (Suherman, 2003: 6) . So it can be concluded that guided discovery method is a method of teaching where learners are given the opportunity to find themselves or guided learners find facts or relationships such as basics, kinds, relationships, traits or certain traits.

There are several things that must be considered in the implementation of guided discovery methods, one of which is the learning process must be adjusted with the knowledge of learners obtained previously. In addition, according to Suherman (2001: 213) in planning teaching with guided discovery methods there are several things that must be considered, namely: a) the activities of learners in self-study is very influential, b) the end result (form) must be found by the learners themselves, C) required prerequisites already possessed by learners, d) teachers acting as directors and supervisors, not informers. In addition to this learning by using this guided discovery according to Widdiharto (2004) can be done individually / individually or in groups.

Guided discovery method is done through several steps. first learners get the problem or information in the form of data from the teacher through LKPD. The learners then process the data to obtain an answer prediction and end by applying the answers they have found in working out the practice questions that have been prepared by the teacher on LKPD. Thus this guided discovery method can be used as a solution to improve students' mathematical reasoning abilities.

Reasoning by Herdian (2010: 1) is a mental process in developing the mind of some fact or principle. According to Fauzan (2012) reasoning ability in mathematics is an ability to use rules, traits or mathematical logic to get a correct conclusion, reasoning is inseparable from reality, because that is difigured is reality, the law of reality in line with the rules of thinking and on the basis of clear reality and using the laws of reasoning.

According to TEAM PPPG in Fauzan (2012) the indicators of Traffic reasoning are: (1) Present mathematical statement orally, written, drawing and diagram, (2) Conjegtures, (3) Math manipulation, (4) (5) Drawing the validity of an argument, (7) Finding the pattern or nature of mathematical phenomena to make generalizations.

From the above explanation and literature study it can be assumed that guided discovery methods can develop and improve students' mathematical reasoning abilities.

CLOSING

From the description above, it is suspected that guided discovery methods can develop or improve students' mathematical reasoning abilities. Guided discovery is a mental process whereby learners assimilate a concept or principle. Mental processes such as learners are stimulated, encouraged, motivated to find themselves from mathematical problems with teacher guidance. At the time of the learning process teachers can help learners grow independently by obtaining information / data and then processing the data through LKPD to obtain an answer forecast. Finally learners apply the answers that have been found by doing the exercise questions that teachers have prepared on LKPD in accordance with indicators of mathematical reasoning ability.

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THE EFFECT OF STAD LEARNING MODEL TO IMPROVETHE CAPACITY OF THE PROBLEM AND MATHEMATICALCOMMUNICATIONS TO PARTICIPANTS

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Abstract

This study aims to see the effect of learning models to improve communication skills and math problem solving skills of learners. Low ability of communication and problem solving ability caused by learners having difficulties in learning mathematics such as learners less able to dig their own information in learning because they are accustomed to the explanation of teachers in front of the class, learners are less able to understand the math materials learned, the level of seriousness of learners in reviewing the subject matter is still relatively low, the learners are less involved in solving problems. As a result, the potential that is in students in learning and mastering the concept of mathematics can't develop maximally so when given the problem of problem-solving ability is not able to solve it. The solution is used as an alternative in improving the problem solving skills of mathematical learners through STAD learning model. STAD learning model, the teacher provides a subject matter and the students in the group ensure that all members of the group can master the subject matter. The research method used is research literature study that is by collecting various information about STAD type cooperative learning model. After conducting literature study by citing data about STAD type cooperative learning model from various sources so it is suspected that STAD learning model can improve problem solving ability and mathematical communication of learners.

Keywords: *STAD Learning Model, Communication Skill, Problem Solving Ability.*

PRELIMINARY

Mathematics is a subject that has important roles and functions for students at every level of education ranging from elementary school (SD) even up to college for some majors. There are many reasons why mathematics has an important role or function for students. As suggested by Cornelius (in Abdurrahman, 2012: 204) that there are five reasons for the need to study mathematics because mathematics is (1) a clear and logical means of thinking, (2) the means to solve problems of everyday life, (3) Patterns of relationship and generalization of experience, (4) means to develop creativity, and (5) means to raise awareness of cultural development.

National Council of Teachers of Mathematics (NCTM) states that problem-solving and mathematical communication skills are two abilities that students must possess. The skills that students need to have through the mathematics learning set by NCTM (2000: 29) are: (1) problem solving; (2) reasoning and verification; (3) communication;

(4) connections; (5) representation. These skills include high-level mathematical thinking that must be developed in the process of mathematical learning.

Based on the above description, the ability of problem solving and mathematical communication are two very important capabilities and become the main focus to be developed and owned by students through learning mathematics in school. Problem-solving skills are needed to understand and solve problems.

With regard to the importance of problem-solving abilities, Sumarno (2010) states that problem-solving skills are important, because through problem solving students can (1) identify the adequacy of data for problem solving; (2) create a mathematical model of a situation or everyday problem and solve it; (3) choosing and implementing strategies for solving mathematical problems or outside mathematics; (4) explain and interpret the results according to the problem of results according to the original problem, and check the correctness of the result or answer; (5) applying mathematics meaningfully.

Furthermore, no less important than the problem solving is a mathematical communication. According to Sumarno (2008) states that communication is a very important part in learning mathematics, because through communication (1) mathematical ideas can be exploited in various perspectives; (2) students' thinking can be sharpened; (3) understanding growth can be measured; (4) students' thinking can be consolidated and organized (5) mathematical knowledge and and development of student problems are constructed; (6) students' reasoning can be improved; (7) student communication can be established.

From some of the above descriptions indicate that the importance of possessing problem solving skills and mathematical communication is of paramount importance. Given the importance of problem solving skills and mathematical communication in mathematics learning, problem-solving and mathematical communication skills should be improved. The reality of the field shows that the problem solving ability and mathematical communication of students is still low. Sumarmo's research (1993) shows that the students' formal thinking level is still not optimally developed, and problem-solving ability is still low. Then the research of Rohaeti (2003) states that the average of KKM students are in less qualification in communicating mathematical ideas included in the category less once.

Some opinions that have been described above show that problem solving ability and mathematical communication of students is still low. The cause of low mathematical problem solving ability is the level of formal thinking of the students is still not developed optimally. Then, one of the causes of the low ability of students' mathematical communication is because students are less able to communicate mathematical ideas in learning mathematics. Therefore, students' problem solving and mathematical communication skills must be developed and improved.

Based on the above problems then we should be as an educator able to create learning that can improve problem solving skills and mathematical communication of students so that the purpose of learning mathematics can be achieved. Because the solving ability can be achieved when students are exposed to conditions that can elicit students' desire to practice their problem-solving skills, the condition is raised during the learning process. This means that a teacher must choose theories, models, methods, approaches, strategies and learning techniques that can improve student problem solving skills.

The use of various theories and learning models in teaching becomes imperative for a teacher when doing the learning process in the classroom. The requirement is contained in Permendiknas no. 16 year 2007 regarding standard of academic qualification and teacher competence, competence related to use of various model or approach in teaching is pedagogic competence. Therefore, in this literature study the author gives solution one of the learning theory that can support and improve the problem solving skills and mathematical communication of junior high school students is cooperative learning model Student Teams Achievement Division (STAD).

Student Teams Achievement Division (STAD) is a model of cooperative learning that is considered to generate student interest in mathematics materials and make students more active, encouraging cooperation among students in learning a material, so as to improve problem solving skills and students' mathematical communication. Learning STAD is considered as one type of cooperative learning that can motivate learners to improve the quality of problem solving skills and students' mathematical communication.

Based on the problems that have been found above, it is suspected that STAD learning model can improve students' problem solving ability. And therefore the authors conducted a study using literature study method entitled "the influence of STAD learning model to improve communication skills and solving math problems to learners".

METHOD

This paper is a literature study which is a study of the literature. As it is conveyed (M. Nazir, 2003: 27) that the technique of data collection by conducting studies of the study of books of literature, records, and reports relating to the problem solved. Here the researcher can gather information relating to the background of the research, theories underlying the problem to be researched, the reference material relevant to the problem or topic to be researched and the results of previous similar research. In addition, literature studies also deepen and increase the knowledge of researchers in terms of theory and research methodology.

RESULTS AND DISCUSSION

Problem solving is a part of teaching and learning strategy that is very important especially in teaching and learning activities of mathematics. This is as stated by Hudojo (2005: 130) states that problem solving has an important function in teaching and learning activities in mathematics. Through problem solving students can practice and integrate the concepts, theorems and skills learned. Furthermore he also said that teaching students to solve problems allows students to be more analytical in making decisions in life.

In other words, when a student is trained to solve a problem, the student will be able to make a decision because the student becomes skilled about how to gather relevant information, analyze information and realize how much research needs to be re-examined. In solving the problem it is necessary to consider the steps in its completion. According to Polya (1973: 5), there are four main stages in the process of solving mathematical problems, namely: First, we have to understand the problem; We have to see what is required. Second, we have to link up to the data, in order to obtain the idea of the solution, to make a plan.

Third, we carry out our plan. Fourth, we look back at the completed solution, we review and discussit.Meanwhile, according to Krulik and Rudnick (in Carson, 2007: 7) says that there are five steps that can be done in solving problems, namely: 1) Read and think (2) Explore and plan (3)) Select a strategy, 4) Solve (solve problems), and 5) Review and extend (review and discuss).

Dewey (Carson, 2007:7): (1) Confront problem, (2) Diagnose or define problem (diagnose and define the problem), 3) Inventory multiple solutions, 4) Conversion problems, (2) Diagnose or define problems (4) Conjecture consequences of solutions, and 5) Test consequences. Based on the description of the troubleshooting steps mentioned above it can be seen that activity in the second and third steps of Krulik and Rudnick is similar to the second step of solving Polya problem. While the first and second step activity of Dewey is the same as the first step of solving Polya problem. A comparison of the troubleshooting steps from the three opinions above is summarized in the following table.

Table 3.1 Comparison of Troubleshooting Steps

Troubleshooting steps		
Krulik dan Rudnick	**Polya**	**Dewey**
2. *Rad and think*	2. *Understand the problem*	3. *Confront problem*
		4. *Diagnose or define problem*
3. *Explore and plan*	4. *Devise a plan*	5. *Inventory several solutions*
5. *Select a strategy*		
6. *Find an answer*	6. *Carry out the plan*	7. *Conjecture consequences of solutions*
8. *Review and extend*	6. *Look back*	7. *Test consequences*

Although there are different indicators of problem-solving abilities from some experts, the ones that will be discussed in this literature study are indicators of problem-solving skills according to the polya. Here are the troubleshooting steps according to Polya along with the problem solving indicator.

Mathematical communication can be interpreted as a student's ability to convey something he knows through dialogue or interrelated events that occur in the classroom environment, where there is a transfer of messages. The transferred message contains the mathematics material that the student is learning, for example in the form of concepts, formulas, or problem solving strategies. Parties involved in communication events in the classroom are teachers and students. The way the message can be transmitted can be spoken or written. Opinion about the importance of communication in learning mathematics also stated NCTM (2000: 63) that the school's mathematics learning program should provide opportunities for students to:

- Develop and link their mathematical thinking through communication
- Communicate their mathematical thinking logically and clearly to their friends, teachers, and others.
- Analyze and assess mathematical thinking and strategies used by others.
- Using mathematical language to express math ideas correctly.

NCTM states understanding of communication by mathematics is shown by writing specifically in the form of communication skills. The abilities in question are: (1) reading and writing mathematics and interpreting the meanings and ideas of the writing; (2) expressing and explaining thinking about mathematical ideas and their relationships; (3) formulating mathematical definitions and making generalizations encountered through investigation (5) using vocabulary / language, mathematical structural notation for presenting ideas, describing relationships, and modeling; (6) understanding, interpreting and assessing ideas presented orally, written, or Visual, (7) observing and making conjectures, formulating questions, collecting and valuing information, and (8) generating and presenting convincing arguments.

According Sumarmo (2014), the ability of mathematical communication is an ability that can include and contain various opportunities to communicate in the form of:

- Reflecting real objects, drawings, and diagrams into mathematical ideas.
- Model situations or problems using oral, written, concrete, graphic, and algebraic methods.
- State day-to-day events in language or mathematical symbols.
- Listening, discussing, and writing about math.
- Reading with an understanding of a written mathematical presentation.
- Create connectors, construct arguments, formulate definitions, and generalize.
- Explain and make questions about mathematics learned.

The ability of mathematical communication can be seen from two aspects namely oral communication (talking) and communication writing (writing). Oral communication is expressed through the intensity of student involvement in small groups during the learning process. While the meaning of mathematical communication writing is the ability and skills of students using vocabulary (vocabulary), notation and mathematical structure to express relationships and ideas and understand it in solving problems. This ability is expressed through mathematical representation. Student math representation is classified into three categories:

- Appearance of conceptual models, such as drawings, diagrams, tables and graphs (drawing aspects)
- Establish mathematical model (aspect mathematical expression)
- Verbal arguments based on analysis of formal drawings and concepts (written texts aspect).

Communication skills play a role in Mathematics Learning. In general, mathematics focuses on representation and communication in various ideas, ideas, and relationships that are numerical, spatial, and pertinent to the data. There are many learning activities that support this theme, such as students who can interpret their own conceptual ideas, ideas, or thoughts into symbolic forms and can be transformed into verbal images of the situation. Other activities can be by investigating a problem, writing a problem, giving information (notation) or allegations (hypothesis) to explain the observations in mathematics. The role of communication in mathematics is enormous, because when students communicate ideas, ideas or mathematical concepts, they learn to clarify, refine and unite thoughts.

Jazuli (2009) states that communication is a very important part in learning mathematics. The importance of mathematical communication is also put forward by Peressini and Bassett (quoted Izzati and Suryadi, 2010) that without communication in mathematics we will have little information, data, and facts about students' understanding of the processes and applications of mathematics. This means, communication can help students in understanding and exploring mathematics into the concepts and processes of mathematics they learn.

In the process of learning and teaching activities (KBM) there is an interaction between teachers and students by communicating with each other both orally, writing, eye contact, body language, and drawing. Through good teacher-student interaction, a teacher can know the ability or potential of each student on the material that is viewed from how the student responds, the student asks, and the student can inform the math idea to the friend or teacher. Through communication, ideas and ideas become objects of reflection and discussion and understanding. With the communication process can help build the meaning of an idea to be known public. In the KBM process, students and teachers engage in mathematical communication both orally and in writing that occur both inside and outside the classroom so as to enhance their understanding of mathematical concepts. Referring from the above exposure, then to improve problem solving skills and mathematical communication of students it can be used cooperative learning model learning type Student Teams Achievement Division (STAD).

This is also supported by the results of research that has been done by Rustam Siregar (2012) at high school level concluded that STAD type cooperative learning model can be one alternative to improve and improve students' mathematics learning result especially for problem solving aspect and student mathematical communication . It can be seen from the result of index data analysis from both variables which shows that the improvement of problem solving ability and mathematical communication of students is increasing by using learning model of cooperative learning STAD type.

Next, it is supported by the result of Dafriendri research (2014) that the STAD type cooperative learning model enables students to express different ideas and ways in problem solving process. And from analiss data about the achievement of research objectives, obtained the fact that an increase in the number of students who reached the KKM before the action. In other words the application of STAD type cooperative learning model can improve the ability of mathematical communication. Based on some of the above description and supported by previous relevant research, it is suspected that the problem solving ability of mathematical communication of learners can be improved by using cooperative learning model of STAD type learning.

CONCLUSIONS AND SUGGESTIONS

Learning model of cooperative learning type STAD is a learning model that can improve problem solving skills and mathematical communication of learners. Student Teams Achievement Division (STAD) is a model of cooperative learning that is considered to generate student interest in mathematics materials and make students more active, encouraging cooperation among students in learning a material, so as to improve problem solving skills and students' mathematical communication. Learning STAD is considered as one type of cooperative learning that can motivate learners to improve the quality of problem solving skills and students' mathematical communication.

Based on literature studies that have been done then the authors suggest:

1. For teachers or educators who want to improve problem solving skills and mathematical communication of students then the learning model cooperative learning type STAD is one alternative that can be applied to learners.

2. For the next writer who wants to write about STAD it is suggested to study how to improve students' mathematical ability by using STAD on other variables, such as connection ability, student motivation and others.

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LEARNING DEVICE DEVELOPMENT WITH MODEL ELICITING ACTIVITIES (MEAS)TO IMPROVE MATHEMATICAL CRITICAL THINKING ABILITYOF STUDENTS GRADE XII SMA PADANG

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Abstract

This research is background because the learning process is still dominated by the teacher so that students' critical thinking ability does not develop. To create a learning process that develops students' critical thinking skills, one alternative is to develop learning tools with Model Eliciting Activities (MEAs). This study aims to produce RPP and LKPD by using Model Eliciting Activities (MEAs) approach which has good validity, practicality and effectiveness. The critical thinking ability is one of the aspects that must exist in the learning process, especially the learning of mathematics. This critical thinking ability needs to be developed becauseby the critical thinking, students can more easily understand the concept, sensitive to problems that occur so as to understand and solve problems and able to apply the concept in different situations. Model Eliciting Activities (MEAs) is a learning approach for understanding, explaining and communicating concepts that contained in a problem through the stages of the mathematical modeling process. This approach will focus students' activities on obtaining a settlement of the real problems provided through the process of applying mathematical procedures to form a mathematical model. So through the Model Eliciting Activities (MEAs) its expected that students' critical thinking skills can be good because students not only produce mathematical models but also understand the concepts used in making mathematical models of the given problems.

Keywords: *RPP,LKDP, Model Elicitng Activities (MEAs), The critical thinking ability*

PREMILINARY

One of the focus of the objectives of mathematics learning in Curriculum 2013 is to develop students' skills to understanding mathematical concepts, explaining interconnectedness between concepts, and using concepts or algorithms in a flexible, accurate, efficient and appropriate way to solve problems. Based on the demands of the curriculum then today the development of learning process in Indonesia is very demanding the students to be actively involved in the process of learning activities so that their thinking ability become more developed. Related to this, students are required to have a higher thinking ability. This is because thinking is a mental activity that someone does to help formulate or solve problems and make the right decision in accordance with what they want (Johnson, 2007).So it can be said that the activeness of students to get the knowledge is something that is essential to instruct students' thinking ability one of them think critically. Critical thinking ability is one of the important aspects that students really need in the learning process of mathematics especially to help students solve difficult mathematical problems

In fact, the learning process that occurs in the classroom has not been able to make the students active so students' critical thinking ability undeveloped. Teachers still use direct learning that makes students feel saturated and tortured so has been cosequence to the students' critical thinking ability as an effort to facilitate students to the ability to think critically develop, that is with a learning where the learning must start from the learning that makes students active so that students freely to think and question what they received from the teacher.It is proposed Ibrahim (2007) that to bring to the learning that can develop the ability of critical thinking must depart from the learning that makes students active. To create active students who can develop critical thinking ability, in addition to the selection of appropriate learning approaches and strategies, there is also a need for device development. Related to this, Lesh proposed a learning approach that can explore students' thinking ability in understanding the concept by communicating their mathematical thinking through mathematical modeling that is Model Eliciting Activities (MEAs)

According to Chamberlin, mathematics learning with the Model-Eliciting Activities approach (MEAs) is an alternative approach that seeks to enable students to be actively involved in the learning process of mathematics in the classroom. The eliciting activities model (MEA) will give students an enormous opportunity to explore their knowledge in learning mathematics, it is expected to make the students change their perception that mathematics as a lesson is not difficult and the students actually learn math. Student learning process using model eliciting activities (MEA) becomes meaningful because students can relate the concepts reviewed by familiar concept and emphasize the students to learn actively

In the MEAs approach raises a real problem is one of its characteristics. By raising real problems it can more easily to connect the abstract mathematical concepts by students. Easily to understand the problems given, it is expected that students can more easily translate the problem either into the form of images and mathematical symbols. In addition to presenting a realistic problem, learning with the MEAs approach involves the activity of creating mathematical models. So it can bring the student's interest to the problem and make it active to find the solution. The Activeness of the students is manifested in one of the characteristics of the MEAs approach of giving students the opportunity to take control of their own learning by raising student-related issues. With the realization of student activeness through the MEAs approach will also make students' critical thinking skills develop. Thus, this learning is expected to lead students to present the idea of mathematics by translating the problem into a mathematical form either in the form of images or mathematical symbols so that students' critical thinking ability development

METHOD

This study includes a type of literature study, where literature studies are the means used to collect data or source data related to the topic raised in a study. This research is about Model Eliciting Activities (MEAs) and critical thinking ability

RESULT AND DISCUSSION

Based on the results of literature studies that have been done, it is found that critical thinking is part of high-order thinking skills that must be owned in the learning process, especially learning mathematics. Baron and Stemberg (1987) suggest that critical thinking is a focused mind for deciding what is believed to be done. A similar opinion was also expressed by Ennis (1991) that defines critical thinking as a process of using rational and reflective thinking skills aimed at making decisions about what is believed or done. Furthermore, John Chaffee (Ibrahim, 2007) defines critical thinking as thinking that is used to systematically investigate one's thinking process in using evidence and logic to the thinking process. Meanwhile, according to Wijaya (Ibrahim, 2007) that critical thinking leads to the activities of analyzing ideas in a more specific direction, distinguishing things sharply, choosing, identifying, studying and developing in a more perfect direction. From the opinion of the experts above can be concluded that critical thinking is a rational, reflective and systematic mind to choose, identify, review and develop in making

The ability to think critically is an important component that must be possessed by students especially in the process of learning mathematics. It is intended that students are able to create or formulate, identify, interpret and plan problem solving. The important thing about critical thinking according to Ennis (2011), that is critical thinking is focused into the notion of something done consciously and leads to a goal. Where one of the most important goals is to help a person make the right and best decision of his life. In addition, Ennis (1991) also revealed that there are six basic elements of critical thinking that must be developed in learning that is; Focus, reason, conclusion, situation, clarity and thorough examination

Students who are able to think critically mathematically are students who do not just accept or reject something They will observe, analyze, and evaluate information before determining whether they accept or reject information. In critical thinking students are required to use certain appropriate cognitive strategies to test the discernment of ideas, problem solving, and problem solving. This critical thinking ability needs to be developed in the students because through the ability to think critically the students can more easily understand the concept, sensitive to the problems that occur so as to understand and solve problems and be able to apply the concept in different situations

Model Eliciting Activities (MEAs) is a learning approach for understanding, explaining and communicating concepts contained in a problem through the stages of the mathematical modeling process. Activity Model-Eliciting Activities (MEAs) encourage students to create a test model. Teachers provide open issues designed to challenge students to build models for solving problems. The activities of the MEAs lead to how students can solve mathematical problems through a mathematical modeling and are depicted into real-life.This can encourage students to be able to describe, revise, or model the ideas they get into mathematical models. This approach will focus students' activities on getting or obtaining a settlement of the real problems provided through the process of applying mathematical procedures to form a mathematical model. Through the process of modeling students are expected to develop their thinking ability, especially critical thinking ability. During the modeling process, students will be given guidance in making a model by considering the steps of forming a model

In the first stages, students identify real life-related problems and declare them in the most precise form possible. In the second stage, students create a possible mathematical model of the given problem situation. At this stage it is possible to develop students' critical and creative thinking skills, as students repeatedly use their thinking skills to determine the most appropriate mathematical model. The third stage, students analyze the model so that the model can solve the existing problems. In the fourth stage, students are asked to match the mathematical solution obtained into the first situation.

After students pass through all four stages of the modeling, in the MEAs students are asked to present their work results and examine the mathematical models that have been made through the reflection sheet that have 3 questions related to the mathematical model. The first question relates to the aspect of representation by asking the answer made to have presented the mathematical model or not. The second question relates to the aspect of validity by asking the mathematical model that is made is correct or not. And the third question relates to aspects of application by asking which mathematical model has been made can be used in other mathematical concepts what not. Based on the learning stages of MEAs, it is possible to develop students' thinking skills, especially critical thinking of the students, because each stage of learning requires the ability to identify problems, give reasons, provide many different answers, and determine possible answers. Thus, through the MEAs students are expected to develop the ability to think in the field of mathematics, especially developing the ability to think critically focused, reason, and overview and the ability to think creatively aspects of fluency, flexibility, and originality. Thus, learning with learning approach of Model Eliciting Activities (MEAs) is expected to have an effect on students' mathematical critical thinking ability

CLOSING

From the above description, it is suspected that the learning device development of the Model Eliciting Activities (MEAs) can improve or develop students' critical thinking ability. Learning with the Model-Eliciting-Activities (MEAs) approach is an alternative approach that seeks to enable students to be actively involved in the learning process of mathematics in the classroom. The students' activity is manifested in one of the characteristics of the MEAs approach of giving students the opportunity to take control of their own learning with process guidance (Chamberlin, 2005). With the active involvement of students in the learning process, it is expected that students' critical thinking skills in mathematics will continue to be well trained.

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AN ANALYSIS OF REPRESENTATION AND DISPOSITION MATHEMATICAL STUDENT'S SKILL THROUGH THINKING ALOUD PAIR PROBLEM SOLVING (TAPPS)WHICH IS REVIEWED FROM EARLY SKILL OF MATHEMATIC

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Abstract

This study aims to analyze the representation and disposition mathematical of student's skill in solving mathematical problems through Thinking Aloud Pair Problem Solving (TAPPS) which is viewed from the early student's skill of mathematical. The skill of representation mathematical is the student's skill to express mathematical ideas in the form of diagrams, tables, graphics, mathematical symbols, mathematical models and words as a tool to solve mathematical problems. The skill of disposition mathematical is the skill to think and act positively that includes interest in learning, persistence and a willingness to find solutions and appreciation toward mathematics. The skill of representation and disposition mathematical is needed to develop student's cognitive and affective aspects. This skill to facilitate students in solving problems, express ideas, survive in take on of problems and develop good job in learning mathematics. Thinking Aloud Pair Problem Solving (TAPPS) is a learning method that uses a problem-solving approach by hard thinking and involving two students working together in solving a problem. This approach will focus on the analysis of student activities to solve mathematical problems both in the form of representation and disposition mathematical seen in terms of early student's skill of mathematical (high, medium and low) by TAPPS. So by looking at early student's skill of mathematical can analyze the skill of representation and disposition mathematical through Thinking Aloud Pair Problem Solving (TAPPS).

Key word: *Representation Skill, Disposition Skill, TAPPS and Early Student's Skill of Mathematical*

INTRODUCTION

Based on the objectives of mathematics learning formulated by the National Council of Teachers of Mathematics (NCTM, 2000), namely: (1) learning to communicate, (2) learning to reason, (3) learning to solve problems, (4) learning to link ideas, (5) learning to represent ideas. Every goal to be achieved in the process of learning mathematics above basically to train students to solve a problem in learning mathematics. Especially in the fourth and fifth items that are closely related to the skill of mathematical representation and disposition. The standard of representation contained in NCTM (2000) states that students during school learning have the skill to:

1. Creating and using representations to organize, record and communicate mathematical ideas.

2. Selecting, applying and translating mathematical representations to solve problems.
3. Using representation to model and interpret physical, social, and mathematical phenomena.
4. Mathematics is an abstract subject, so it takes the skill to make mathematical ideas become more concrete.

Based on the above standards, the usefulness of these skills can make students free of imagination and creative thinking in the form of images, symbols, oral, graphic or written text, so as not to memorize the concept alone. This is confirmed by Trianto (2011) that the implication in the learning process is when teachers introduce information that involves students using concepts, giving enough time to find ideas using formal thinking patterns. In the introduction of Arnidha (2016) states that in the learning activities of mathematics in schools, teachers usually use conventional learning methods. Learning activities begin by explaining and giving examples of problems and then proceed with giving practice to students. Learning is centered only on the teacher while the students just sit quietly and listen to the teacher's explanation.

Other facts found by Pramitha (2016) in the preliminary study, the students are less motivated and easily give up in solving mathematical problems that think high level, in addition to the students' attention to the results obtained by students seem to accept what is and "surrender", even when getting value below the minimum mastery criteria students did not want to make improvements. The low positive attitude, self-confidence, and curiosity of the students impact on low learning outcomes. This happens because the learning of mathematics not only develops only cognitive aspects, but also affective aspects, such as mathematical disposition.

Mathematical dispositions relate to how students perceive and solve problems; whether confident, diligent, interested, and open minded to explore various alternative problem-solving strategies. Disposition also relates to the tendency of students to reflect on their own thinking (NCTM, 1991). Sumarmo (2012) agreed with the point (5) Permendiknas No 22 of 2006 that describe affective sphere must be owned by students who learn math. The development of affective aspects of students in mathematics learning requires mathematical disposition, namely desire, awareness, dedication and strong tendency in students to think and do mathematically in a positive way and based on faith, taqwa, and noble character.

Therefore, mathematical disposition is one of the factors supporting the success of students' mathematical learning. Students need a mathematical disposition to stay in trouble, take responsibility, and develop good work habits in learning math. Thus, students who have not understood the mathematical material they are studying can be assured that students need a positive disposition to deal with problematic situations in their lives.

Rosdiana, Subarjah and Isrok'atun (2016) said that through the mathematical disposition is expected students can have a positive view of mathematics so as to achieve the objectives of learning mathematics. Positive attitudes that students give to the learning of mathematics can also affect the improvement of mathematical skill. In addition, mathematical disposition is also the personality or character required by an individual to survive in the face of various problems, have a sense of responsibility towards learning and demonstrate good work habits in math. So the skill of disposition can see student affective aspect analysis and representational skill to see cognitive aspect analysis of students.

In Complete Dictionary of Indonesian Language (2005: 41), analysis is the process of deciphering a subject or its various parts and the study of the part itself as well as the relationships between parts to obtain a proper understanding and understanding the meaning of the whole. The analysis in this research is a process of investigation and quantitative data decomposition of student learning outcomes in learning with TAPPS and qualitatively about the skill of representation and mathematical disposition of students in solving test problems of mathematical representation skill. By developing and analyzing the skill of mathematical representation and disposition it can generate positive values in students and their environment (including teachers and peers using TAPPS type of cooperative learning model (Thinking Aloud Pair Problem Solving).

According to Pramitha (2016) the activity of TAPPS model is done on small group consisting of two people in a heterogeneous and enabling positive interaction among students. So as to increase students' confidence in solving mathematical problems. The two students are given different roles from each other on each problem, ie as problem solver (PS) and listener (L). Suparmono and Kusmanto (2015) The application of cooperative learning model type TAPPS will be able to improve the activity of learning mathematics of students in class VII A because with this learning method students feel not think alone but think together to solve a common problem. So if there are students who feel less able with mathematics can be assisted by friends in groups who are more capable with mathematics.

Apart from the cognitive and affective aspects, the student's early mathematical skill was also used as the focus of this research. This is related to the effectiveness of its implementation in the learning process. The goal is to see whether the implementation of TAPPS learning methods can be evenly distributed across all categories of students' Mathematical skill or only certain mathematical beginning maternity categories. If it is prevalent in all categories of mathematical preliminary skill, this research can be generalized that the implementation of TAPPS learning is suitable for all levels of skill.

Based on the above problems, it is assumed that through TAPPS model can focus the analysis of student activities to obtain the solution of mathematical problems both in the form of representation and mathematical disposition seen from the faculty of mathematical early students (high, medium and low). And therefore the author will carry out research with the title "An Analysis Of Representation And Disposition Mathematical Student's Skill Through Thinking Aloud Pair Problem Solving (TAPPS) Which Is Reviewed From Early Skill Of Mathematic".

METHOD

This study included a type of literature study. Where literature study is a method that uses to collect data or sources related to the topic raised in a study. These data sources contain the skill of representation, disposition, TAPPS and students' early mathematical skills.

FINDINGS AND DISCUSSION

The skill of mathematical representation is the skill of students to express mathematical ideas in the form of diagrams, tables, graphs, mathematical symbols, mathematical models and words as a tool to solve mathematical problems. Cai, Lane and Jacabcsin (Suparlan, 2005) state that representation is the way one uses to express the answers or mathematical ideas in question. Hudoyo (2002) argues that basically representations can be distinguished in two forms, namely internal representation and external representation. Internal representation is the understanding of each student on a material that has been described and translated according to each student's understanding while external representation is the result of the embodiment to describe what students do, teachers, or mathematicians. The result of the embodiment may be oral, written, words, symbols, expression or mathematical notations, drawings, graphs, diagrams, tables or through props.

The indicators used in assessing the skill of mathematical representation are shown in the following table.

Table 1. Indicators of Student Mathematical Representation Skill

No	Representation	Operational Forms
1	Visual Representation a. Charts, tables or graphs	• Present data or information from a representation to a representation of diagrams, graphs, or tables. • Using visual representations to solve problems.
	b. Picture	• Draw geometry patterns. • Make a drawing to clarify the problem and facilitate its completion.
2	Equations or mathematical expressions	• Create equations or mathematical models of other representations provided. • Create conjectures of a number pattern. • Problem solving by involving mathematical expressions.
3	Words or written text	• Create a problem situation based on data or representations provided. • Write an interpretation of a representation. • Write down steps to solve mathematical problems with words. • Compile stories that correspond to a representation presented. • Answering questions using written words or texts.

(Yudhanegara & Lestari, 2014)

These three aspects of representation are visual, mathematical, or mathematical expressions, and the representation of written words or texts is noticed. In addition to representational skills, this study also analyzes the skill of mathematical disposition. According to NCTM (2000), mathematical dispositions include the willingness to take risks and explore the solutions of diverse problems, persistence to solve challenging problems, take responsibility for reflecting on the work, appreciate the communication power of the mathematical language, the willingness to ask questions and propose ideas, Other mathematical ideas, the willingness to try different ways or strategies, have confidence, and view the problem as a challenge. NCTM (1989) describes mathematical dispositions including the following components:

1. Confident in using math to solve problems, communicate mathematical ideas, and give arguments.
2. Think flexible in exploring mathematical ideas and try alternative methods in solving problems.
3. Being persistent in doing mathematical tasks.
4. Interested, have curiosity, and have creativity in bermatematis activity.

5. Monitor and reflect on thinking and performance.
6. Appreciate mathematical applications in other disciplines or in everyday life.
7. Appreciate mathematical roles as a tool and as a language.

Based on the above indicators there are 7 components in the skill of mathematical disposition that shows confidence, expectations and metacognition, serious attention in learning mathematics, persistence in dealing with and solving problems, high curiosity and the skill to share opinions with others. Tresnawati (2013) Disposition is the character or personality that an individual needs to succeed. Students need a mathematical disposition to stay in trouble, take responsibility in their learning and develop good work habits in mathematics. Such characteristics are important for students to develop and develop in the learning process to deal with problematic situations in their lives. Merz (2009) There are two sketches in the disposition in which teacher roles and perceptions play a role or equally important in observing and developing a student's mathematical disposition.

Developing this analysis of mathematical representation and disposition skills can bring positive values to students and their environment (including teachers and peers). Therefore, the implementation of learning using cooperative learning model TAPPS type. Keywords of this TAPPS are Thinking Aloud, Pair, and Problem Solving. Musanif (2007) thinks that Thinking Aloud means thinking hard, Pair means pairing and Problem Solving means problem solving. So TAPPS can be interpreted as a technique of thinking hard in pairs in problem solving which is one of the learning methods that can create active learning conditions to students. Here is the details of the task of problem solver and listener which is a combination of Hartman (1998).

1. Task Problem Solver
   A problem solver has the task of reading the problem and then proceeds to reveal all the things that are thoughtful both in the form of ideas and ideas to solve problems in the matter, revealing all the stages that will be done to solve the problem not to be missed from the small, easy , Clear or unimportant, for example: what to do, when, why, and how, expresses all thoughts used when solving a problem.
2. Task Listener:
   A listener on duty to help problem solver see what they are doing, this means a listener must make problem solver reveal what problem solver do. A listener should not give an answer to the problem being solved by problem solver. A listener has a duty to think with Problem Solver, follow each stage and understand each stage. Once the problem solver identifies and defines important terms, variables, rules and procedures and then ensures that the Problem Solver has done all the stages correctly. If the problem solver missed the stages in solving the problem ask and ask for the missed explanation. Do not work, listen and work together to solve problems. If you do not understand, then ask the problem solver, follow and check the problem solving step taken problem solver by checking the steps or calculations performed by problem solver, if listener find errors made by problem solver avoid to correct, help problem solver solve problem By providing a guiding question that leads to the correct answer.

Based on the above task details, it is seen in the research of Pate, Wardlow and Johnson (2004) Students who participated in the TAPPS group were given a listener partner and verbally expressed their thought processes. Among the students who successfully completed the problem-solving tasks in both groups, there were no significant differences in the time required to complete them. Implementation of TAPPS model that demands students' mental and psychological activity. Students must first be conditioned to have an interest, linkage, spirit, and self-confidence, so that students do not feel anxious and embarrassed and even reluctant when trying to solve mathematical problem solving. So in this research will focus on student activity analysis to get the solution of mathematics problem either in the form of representation and mathematical disposition which seen from faculty mathematical early (high, middle and low) via TAPPS model.

CONCLUSIONS AND RECOMMENDATIONS

TAPPS is a learning method that uses a problem-solving approach by thinking hard and involving two students working together in solving a problem. Groups are divided heterogeneously as Problem Solver and Listener. In TAPPS, an analysis of the skill of representation and mathematical disposition of students was performed. The skill of mathematical representation is the skill of students to express mathematical ideas in the form of diagrams, tables, graphs, mathematical symbols, mathematical models and words as a tool to solve mathematical problems. The skill of disposition is the willingness to take risks and explore the solutions of diverse problems, persistence to solve challenging problems, take responsibility for reflecting on the work, appreciate the communication power of the mathematical language, the willingness to ask and propose other mathematical ideas, Try different ways or strategies, have confidence, and view the problem as a challenge. The use of TAPPS can analyze students' activities to solve mathematical problems both in the form of mathematical representation and disposition seen in terms of early mathematical high school students (high, medium and low).

Based on literature studies that have been done, the authors recommendation:

1. To be able to analyze students' mathematical representation skills for each type of early mathematical skill of students (high, medium and low) in the context of TAPPS learning.
2. To be able to analyze students' mathematical disposition skills for each type of early mathematical skill of students (high, medium and low) in the context of TAPPS learning.
3. It is expected to analyze other mathematical skills.
4. For the next author to examine more extensively about the skill of representation and disposition through TAPPS.

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MODIFIED MEANS-ENDS-ANALYSIS MODEL WITH DIDACTICAL ENGINEERINGTO ENHANCE JUNIOR HIGH SCHOOL STUDENTS'MATHEMATICAL CRITICAL THINKING ABILITY

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Abstract

This article presents the results of the implementation of a modified Means-Ends-Analysis (MEA) learning model with Didactical Engineering (DE) to enhance students' mathematical critical thinking ability. Didactical engineering was implemented in designing teaching materials. The research adopted a quasi-experimental method with a pretest-posttest design. The population of this research was all eighth grade students of state junior high schools in Subang regency. The sample involved 158 eighth grade students from two junior high schools at the high and medium levels. The sample for the experimental group and control group was randomly selected on the basis of grades. The instruments used were tests of prior mathematical ability and critical thinking ability test. Research data of students' pretest, posttest, and normalized gain scores for mathematical critical thinking ability were analyzed using mix-methods, i.e. a combination of quantitative and qualitative analyses adapted to the existing data. Based on data analysis results, it is found that there is a significant difference in the enhancement of students' mathematical critical thinking ability between the experimental and control groups. The enhancement of mathematical critical thinking ability of the experimental group students who were taught with the modified MEA model with DE is significantly greater in each category of their prior mathematical ability both in the schools of the high and medium levels compared to the enhancement of the students who were taught with conventional learning model. However, the greatest enhancement in the mathematical critical thinking ability is attained by students with the high category of prior mathematical ability at a high-level school, and the lowest enhancement was attained by students with low prior mathematical ability from the medium-level school. The results of this study also show that there is no interaction effect between the modified MEA model with DE, the conventional learning model, and students' prior mathematical ability on the enhancement of students' mathematical disposition.

Keywords: *Modified MEA Model, Didactical Engineering, Mathematical Critical Thinking Ability*

INTRODUCTION

Enhancement in mathematical critical thinking ability is one of the foci in mathematics instructional activities. Through mathematics instruction, all learners starting from primary school are expected to acquire logical, analytic, systematic, critical, and creative thinking skills, as well as cooperative skills (The National Agency for Education Standards, 2013, p.146). Similarly, Sabandar (2010, p.178) suggested that critical mathematical thinking ability is one of the main objectives in mathematics activities, and is considered important by both teachers and students. Paul and Elder (2008) also revealed that higher order thinking skills are currently required by students to enhancethe quality and originality of their intellectual thinking. Thus, higher order thinking skills, especially mathematical critical thinking skills, should and must be continuously developed in the learning of mathematics. In other words, the ability to think critically must be formed in students through learning mathematics. Improvement in mathematical critical thinking ability is necessary because this ability is one of the most important abilities for the future of each learner.

According to Hamid (2016, p. 497), mathematical critical thinking ability should be developed in all students, because every human being has the potential to think critically. Other authors, such as Duron, Limbach, and Waugh (2006, p. 163) believed that thinking is a natural process, and when left alone, it is often biased, distorted, partial, lacking information, and potentially prejudiced, so an excellent mind must be developed. This is in line with the opinion of Cotton (cited in Umar, 2013, p. 4) which said that although many people believe that humans are born with or without critical thinking skills, research has shown that mathematical critical thinking can be taught and learned. Thus, mathematical critical thinking ability should be trained and taught to students through learning mathematics, as it will greatly assist them in solving the problems they face.

There are four reasons put forward by Cotton (as cited in Umar, 2013, p. 6) regarding the need to habitually develop mathematical critical thinking ability, namely: (1) the demands of the times that require citizens to be able to seek, select, and use information for the social and society and state; (2) every citizen is always faced with various problems and choices so that they are required to think critically and creatively; (3) the ability to see things differently in solving problems is important; and (4) critical thinking is an aspect in solving problems creatively so that learners can compete fairly and cooperate with other nations. Meanwhile, Kusumah (2008, p. 23) argued that critical thinking ability, as part of mathematical thinking ability, is very important. It should be developed through mathematical learning activities, which are focused on the systems, structures, concepts, principles and strict relationships among elements. On the other hand, Ruseffendi (2010, p. 64) said that mathematics is formed as a result of human thoughts related to ideas, processes, and reasoning. He further stated that mathematics is reasoning. In other words, mathematics as a discipline that develops critical and dynamic thinking and open-mindedness cannot be separated from reasoning. This argument is reinforced by Sumarmo (2013, p. 17) who declared that mathematical critical thinking ability is part of reasoning.

Indeed, efforts to enhance the quality of education are inseparable from the role and responsibility of educational institutions. Improving the quality of education, especially mathematics subject in every school, should always be pursued. The efforts to enhance the quality of mathematics subject by developing mathematical critical thinking ability should be viewed as something urgent and cannot be underestimated. Such efforts, of course, cannot possibly be made through the old ways that tend to rely on a more procedural and less challenging capacity development. These efforts need to be further developed so as to touch aspects that enable learners to develop their potential optimally. It certainly indicates at least that to enhance students' critical thinking ability through mathematics learning is inseparable from the ability of comprehension. Solihin (2011, p. 68) in his study reported that there was a positive correlation between mathematical understanding ability and mathematical critical thinking ability. The finding suggests that mathematical materials cannot be understood properly and correctly if not studied with the correct mathematical critical thinking ability. Conversely, for students to be able to think mathematically and critically, they must understand mathematics well and correctly. Sutawidjaja (2013, p. 5) said that mathematical critical thinking ability can only be understood and trained through learning mathematics materials; it cannot be taught didactically.

In Indonesia, students have to this date not shown satisfactory results in their mathematical ability; in other words, students' achievements in mathematics learning are still low. These low achievements can be seen from the results of the surveys of measurement and assessment of education by the Program for International Student Assessment (PISA) and The Trends in International Mathematics and Science Study (TIMSS) in 2011 for the category of eighth grade students of junior high school, which reported that Indonesian students' mathematics mastery was ranked 39 out of 43 countries (Turmudi, 2012, p. 104). The results of PISA and TIMSS surveys are supported by Noer's study (2010, p. 7) which showed that mathematical critical thinking ability of the eighth grade junior high school students was less than optimal because only a small percentage of the students (less than 15%) were able to complete various academic tasks; they had only been able to identify the assumptions given, formulate subject matters, and determine the consequences of a decision. Specifically for indicators of the abilities to detect biases based on different points of view, uncover a concept/definition or theorem in solving problems, and evaluate relevant arguments in solving the problems, there were only a minority of the students (5%) who successfully completed the tasks assigned by their teachers.

Furthermore, Noer (2010, p. 8) revealed that the students' mathematical critical thinking ability, which is less than optimal, is allegedly caused bythe inappropriate instructional models and strategies used by teachers in mathematics instruction. Meanwhile, Stacey's (2010, p. 6) study reported that participants from Indonesia were less successful in solving non-routine mathematical problems requiring mathematical reasoning, generalization or conjecture, and finding links between data and facts provided. Sharadgah (2014, p. 170) also reported that most students did not take the meaning of the problem solving process; consequently, the process of constructing a material was less successful. He further reported that the students had not fully mastered the knowledge of problem-solving activities, and on the other hand, the instructional process undertaken by teachers did not really encourage the enhancement of students' mathematical critical thinking ability.

Based on the above explanations, it is clear that an instructional process that can meet the expectation of growing and developing students' mathematical critical thinking ability is absolutely necessary. Thus, in this study the authors implemented the MEA model developed by Glass & Holyoak (cited in Umar, 2011, p. 9) combined with Didactical Engineering (DE) in designing teaching materials. Emprin (2009) stated that didactical engineering is subsumed under developmental research, as it relates to the development of content and instructional materials. Meanwhile, according to Brousseau (2013), DE framework can be formulated as a series of steps in a didactical design aimed at improving the teaching process. On the other hand, Artigue (2009) and Godino & Batanero et al. (2013) explained that DE is used when research positions "didactical design" as an important product, so the research can be said to design a didactical engineering framework. Therefore, according to Suryadi (2013, p. 6), a didactical design basically consists of three stages: (1) analysis of didactic situational planning before instruction, (2) metapedadidactical analysis to support instruction, and (3) retrospective analysis of data generated between instructional planning and the results of metapedadidactical analysis.

From the perspective of didactical engineering presented above, the MEA model with DE implemented in this study is defined as an instructional design with student-centered approach, while the teachers (researchers) only serve as facilitators. The syntax of the modified MEA model with DE is as follow: (1) in the initial instructional process, teachers provide open-ended contextual problems to the students; (2) students, with cooperative learning method, elaborate the problem into simpler sub-problems; (3) during the instructional process, students build their knowledge and develop their mathematical critical thinking ability to solve the problems to be addressed; (4) students independently determine the learning strategy to find solutions to the problems given; and (5) teachers act as facilitators throughout the activities, where if there are students who have difficulty, they will be guided using scaffolding techniques, by asking such questions as: What information is known from the problem? What is known and what to look for and what is the relationship between them? Such questions lead students to take action on the existing situations so as to create a didactical situation that is able to synergize every student's potential to improve students' mathematical critical thinking ability.

Expressed in more detailed formulation, this research problem is formulated in the form of questions as follows: (a) Is the students' enhancement in mathematical critical thinking ability (MCTA) who worked under MEA model with DE better than the worked under the conventional learning model?; (b) Is there any interaction effect between the application of MEA model with DE and prior mathematical ability on the students' enhancemenet in mathematical critical thinking ability? The purpose of this study is as follows: (a) To describe comprehensively the students' enhancement in mathematical critical thinking abilitywho worked under the MEA model with DE and those who worked under the conventional learning model. (b) Analyze the effect of interaction between the application of MEA model with DE and prior mathematical ability on the students' enhancement in mathematical critical thinking ability.

METHOD AND DESIGN

This research adopted the Research & Development method for one year, divided into two stages as follows: (1) The first stage, preparation stage, is the design and development of teaching materials, including development of the evaluation of modified MEA model with DE, as well as the making of research instruments such as: Prior Mathematical Ability (PMA) and Mathematical Critical Thinking Ability (MCTA) test items; (2) The second phase is the implementation stage. In the first phase of the research, for one semester, the research used the one group only design, without a control group: X - O to determine the effectiveness of teaching materials and the implementation of the modified MEA model with DE, and the level of validity, reliability, discriminatory power, and difficulty index of PMA and MCTA test items to the eighth grade students of class VIII-A in one state junior high school in Subang Regency.

In the second phase of the research, a trial of the modified MEA model was carried out to 158 eighth grade students from two junior high schools in Subang Regency representing the high and medium school levels, in which two classes of students were involved from each school. The method used in the second stage was the quasi-experimental one with pretest and posttest, with the following research design: O X O and O---O, where O stands for the pretest-posttest, whereas X illustrates the implementation of the modified MEA model with DE contrasted with the conventional learning model. The experimental group was taught with the modified MEA model with DE and the control group with the conventional learning model. Prior to the treatment, both the experimental and control classes were given the PMA test. The test was to classify students based on the level of mathematical ability that would have some implications for the discussions of the instructional process and learning outcomes. Data on the students' enhancement improvement in mathematical critical thinking ability were obtained through the posttest of MCTA, while data on mathematical disposition of the students were obtained using the disposition scale. To solve the problems addressed in this research, the data were processed and analyzed using mix-methods, i.e. the combination of quantitative and qualitative analyses adjusted to the existing data (Arikunto, 2012). Normality test and test of the assumption of homogeneity of variance were carried out prior to using the combined statistical tests.

FINDINGS AND DISCUSSION

1.1. The Implementation of the Modified MEA Model with DE

Before the teaching materials were used on the actual instruction, the teachers first developed teaching materials of the modified MEA with Didactical Engineering (DE) in three stages: (1) Analysis of didactical situation by the teachers (researchers) before the trial of teaching materials, consisting of predictions and anticipations for each possible student response that would arise from the didactical and pedagogical situations; (2) Metapedadidactical analysis by the teachers during the trial of the teaching materials, including identification and analysis of learning barriers that might arise during the instruction; (3) Retrospective analysis conducted after the trial of teaching materials, containing a reflection of the conformity between the analysis of didactical situation and the metapedadidactical analysis with further didactical and pedagogical actions. So, before the implementation of the modified MEA learning model with DE, the teaching materials were first tested and refined so that the learning barriers that might arise could be anticipated by the teachers. Through the implementation of the modified MEA model with DE, the enhancement of students' mathematical critical thinking can be more optimal compared to the conventional learning model (CLM).

The modified MEA learning strategy with ED can be implemented at the level of individual, group, or class. In this research, the individual learning strategy was implemented at the beginning of the instruction, where the teacher asked the readiness of each student in terms of the materials to be studied. This strategy was implemented to both the experimental and control classes. The group learning strategy was done when students solved problems and presented their work. Finally, the class learning strategy was applied to both the modified MEA group and control group students at the end of the instruction, namely during discussion of the instructional materials.

Meanwhile, the techniques and tactics employed in the instruction using the MEA learning model with DE are as follows: Teachers provide open-ended contextual problems related to the daily life of the students. The problems are understood first by students individually, and then the students determine the strategy to find a solution to the problem given in groups. In this context, during the instructional process, students are required to work in a group of three to four students in the hope of generating problem solutions through written descriptions, explanations, and constructs by repeatedly analyzing the problem to find a mathematical proof. Glass & Holyoak (in Umar, 2011, p. 9) explained that in MEA learning model, students are given the opportunity to use their own strategy, construct their own knowledge, and solve the problem addressed to reach a mathematical proof. At the end of the lesson, students guided by the teachers draw conclusions and make summaries.

The findings on the implementation, objectives, and outcomes of analysis of didactical situation, metapedadidactical analysis, and retrospective analysis of the development of teaching materials for the modified MEA model with DE were compared to those of the conventional learning, as follows: (1) The results of didactical situation analysis will enable the creation of an ideal didactical situation for students. This is possible because the didactical engineering analysis contains teacher thinking about prediction and anticipation of students' responses that will be generated in the didactical situation during the lesson; (2) With metapedadidactical analysis, learning stages will run smoothly and student learning outcomes will be optimal. This can be seen from the teacher's ability to achieve learning targets and expected student responses; (3) From retrospective analysis carried out after instruction, a very good strategy for teacher's self-development can be derived, so that quality of instruction from time to time can be improved. Broadly speaking, the implication of these findings is that there is a tendency that the modified MEA model with DE will have a great influence on the enhancement of mathematical critical thinking ability and mathematical disposition of students compared to the conventional learning model for each category of students' prior mathematical ability.

1.2. Enhancement of Students' Mathematical Critical Thinking Ability (MCTA)

The enhancement of students' MCTA was determined based on the normalized gain between the pretest and the posttest scores obtained by using the same MCTA test items. Based on the Kolmogorov-Smirnov test results on learning models, school levels, and each category of students' PMA, it can be seen that the data of students' enhancement of their MCTA were normally distributed. Next, based on the results of homogeneity test of variance using Levene Test, it is known that the overall data distribution of the students' enhancement in MCTA were homogeneous at the significance level of $\alpha = 0.05$. Data on the attainment of students' MCTA based on learning models, school levels, and PMA are presented in Table 1

Table 1. Data of Students' Mathematical Critical Thinking Ability based Learning Model, School Level, and PMA Category

School Level	PMA	Statistical Measure	Learning Models					
			Modified MEA Model			CLM		
			Pretest	Postest	Gain	Pretest	Postest	Gain
High	High	*N*	8	8	8	7	7	7
		Mean	**12.5**	**36.5**	**0.65**	**6.00**	**28.29**	**0.51**
		SD	3.34	7.84	0.19	2.58	9.41	0.22
	Moderate	*N*	25	25	25	24	24	24
		Mean	**7.52**	**26.08**	**0.45**	**6.17**	**20.17**	**0.31**

		SD	3.23	10.46	0.23	3.33	7.05	0.18
	Low	*N*	7	7	7	7	7	7
		Mean	**4.00**	**17.14**	**0.29**	**3.14**	**10.29**	**0.15**
		SD	4.00	7.38	0.12	1.57	4.23	0.09
Moderate	High	*N*	7	7	7	8	8	8
		Mean	**7.14**	**32.86**	**0.60**	**4.25**	**24.25**	**0.46**
		SD	3.44	5.98	0.15	1.67	7.96	0.20
	Moderate	*N*	23	23	23	23	23	23
		Mean	**7.04**	**24.09**	**0.40**	**4.52**	**19.22**	**0.33**
		SD	4.08	6.37	0.12	1.50	5.93	0.15
	Low	*N*	10	10	10	9	9	9
		Mean	**6.20**	**18.60**	**0.28**	**4.89**	**14.00**	**0.20**
		SD	3.19	7.24	0.15	2.26	5.10	0.11

Note: maximum ideal score 50; SD (standard deviation); N (the number of students)

The data in Table 1 show that in terms of both school levels and prior mathematical ability (PMA), students with high or medium PMA who were taught with the modified MEA model with DE improved their MCTA are better than the control group students who received a conventional learning model. Meanwhile, students with low PMA category who were taught with the modified MEA model with DE at the medium school level achieved a greater normalized gain score for MCTA (18.60) than the control group students at high school level (17.14). For the modified MEA model with DE, the greatest enhancement of the students' MCTA was achieved on the indicator of "Students are able to identify assumptions used to solve a problem". Based on Meltzer's classification (2002), the enhancement is included under the medium category. On the other hand, for the conventional learning model, the lowest enhancement of students' MCTA was achieved on the indicator of "Students are able to uncover a concept and use it in solving the problem", which belongs to the low category. This finding is almost in line with that of Noer's study (2010, p. 10) which found that the most common student weaknesses were in the aspects of formulating the problem and testing the correctness of the answer. Nevertheless, as a whole it turns out that the higher the PMA category at both school levels, the higher the standardized gain of students' MCTA.

Based on the results of descriptive and inferential statistical analyses above, it can be inferred that before the learning treatment, students' mathematical critical thinking ability (MCTA) from both school levels was significantly different. After the instructional process, students' MCTA from both high and medium school levels taught with MEA models with DE was significantly greater than that of the control group students who were taught with the conventional learning model. This finding reinforces the assertion that the modified MEA model with DE is significantly superior to that of the conventional learning model and low prior mathematical ability (PMA) in improving students' MCTA. The advantage of the modified MEA model with DE is also reinforced by the results of a one-way ANOVA with post-hoc test of the interaction effect of learning models, school levels, and PMA categories on the normalized gain of students' MCTA. Theoretically, this advantage can be explained by better quality of teaching materials of the modified MEA model with DE, along with more interactive and meaningful instructional processes than the conventional learning model. Chamot

(2012) said that an ideal teacher is one who is able to choose the right task, encourage students to learn meaningfully, set a discourse to create an atmosphere of learning, and analyze classroom situations. Thus, it seems that the teaching and learning with the modified MEA model with DE has been able to assist the students to head to Vygotsky' Zone of Proximal Development (ZPD) (1978).

Another theoretical explanation is that the implementation of the MEA model with DE is based on a constructivist philosophy that students must be mentally active in building their knowledge structure based on their cognitive maturity. Subsequently, the four principles underlying the modified MEA model with DE are in accordance with Piaget's cognitive development theory that learning is a process of assimilation and accommodation. The process of assimilation in the modified MEA learning model with DE occurs in the implementation of the principle of "presenting materials with heuristic and holistic approaches", while the accommodation process takes place in the implementation of the principle of "problem elaboration; documentation; reusability and sharing-ability; and an effective prototype." In general, the instructional process with the modified MEA model with DE puts more emphasis on students' active participation. Hence, learning is not centered on the teacher but on the students who actively learn and explore their knowledge independently. The constructivist view assumes that students must construct their own knowledge (Suparno, 1997). Meanwhile, Bruner's constructivist theory (in Umar, 2011, p. 11) posits that the best way of thinking for students to start learning concepts and principles in mathematics is to construct on their own. The reason is that if students construct knowledge on their own, they will easily remember and apply the knowledge in relevant situations.

1.3. The Interaction Effect between Learning Factors and Students' PMA on the Enhancement of Students' Mathematical Critical Thinking Ability (MCTA)

Based on the results of descriptive statistical analysis of the mathematical critical thinking ability (MCTA) of the students who were taught with the modified MEA model with DE compared to those taught with the conventional learning model, it can be seen that the data on the mean enhancement of the students' MCTA based on learning models and prior mathematical ability (PMA) categories were normally distributed, so a two-way ANOVA test could not be performed. Thus, the analysis of the interaction effect between learning models and PMA on students' improved MCTA was done descriptively from the resulting graph. The graph of the interaction effect between learning models and students' PMA on the enhancement of their MCTA is presented in Diagram 1.

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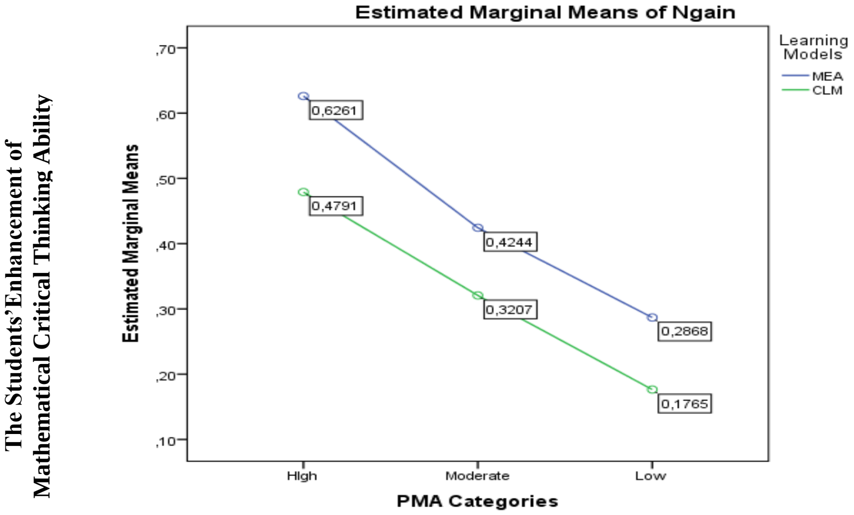

Diagram 1: Interaction between Learning Model and Students' PMA toward Enhancement of Mathematical Critical Thinking Ability

From Diagram 1, it is clear that the mean of the enhancement of the students' MCTA taught with modified MEA model with DE is above that of the students taught with the conventional learning model. The graph shows that students with all PMA categories (low, medium, high) who were treated with the modified MEA model with DE obtained a greater enhancement in their MCTA than the students who received the conventional learning model. Nonetheless, the difference in the enhancement of MCTA between the students taught with the modified MEA model with DE and those with the conventional learning model in the three categories of PMA was dissimilar. In the high PMA category, the difference in the enhancement of MCTA between the students taught with the modified MEA model with DE and those with the conventional learning model was 0.147; meanwhile, the differences in the medium and low PMA categories between students who got the modified MEA model with DE and those taught with the conventional learning model were 0.1037 and 0.1103, respectively. These differences indicate that the modified MEA model with DE had a greater influence on the students' MCTA enhancement compared to the conventional learning model for each of the students' PMA categories.

When viewed from the mean in the diagram for both learning models, it appears that students with higher prior mathematical ability (PMA) category had a greater enhancement than students with medium or low PMA categories; and students with medium PMA category had a greater enhancement than those with low PMA category. In addition, it can also be seen that both "line" graphs have positive gradient, indicating that both the learning models and the three categories of PMA had a significant effect on the students' mathematical critical thinking ability (MCTA) enhancement. The distance between the two "line" in the graph shows that the line for each PMA category tends to be relatively different and does not intersect with other lines. This means that there was a significant interaction effect on the enhancement of students' MCTA based on learning models and PMA. Thus, it can be concluded that the interaction effect between learning models and PMA resulted in significant differences in the enhancements of students' MCTA. The implication is that there is a tendency that the modified MEA model with DE

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had a greater effect on the students' MCTA enhancement compared to the conventional learning model for each of the PMA categories. This finding reciprocates with that of Fitriani's research (2012, p. 53), which reported that the implementation of MEA learning model could positively affect the enhancement of communication skills and mathematical problem-solving skills of eighth grade junior high school students.

1.4. Enhancement of Students' Mathematical Disposition

From the Kolmogorov-Smirnov test results, it is known that data on the enhancement of students' mathematical disposition from the control group with medium PMA category at the medium school level were not normally distributed, while data for the experimental group with high and low PMA categories at the high school level were all normally distributed at the significance level (α) = 0.05. Furthermore, from the homogeneity test of variance using the Non-Parametric Mann Whitney test, it is found that the data on the enhancement of the students' mathematical disposition at the medium school level with low PMA category were not normally distributed, whereas data for the students with high and low PMA at the high school level were normally distributed at the level of significance of α = 0.05. Data on the enhancement of students' mathematical disposition based on learning models, school levels, and PMA categories are shown in Table 2.

Table 2. Data of Students' Mathematical Dispositions Enhancement based on Learning Model, School Level, and PMA Category

School Level	PMA	Statistical Measure	Learning Models					
			Modified MEA Model			CLM		
			Pretest	Posttest	Gain	Pretest	Posttest	Gain
High	High	*N*	8	8	8	7	7	7
		Mean	**87.88**	**104.75**	**0.31**	**87.71**	**94.29**	**0.111**
		SD	7.97	14.14	0.16	12.079	11.280	0.698
	Moderate	*N*	25	25	25	24	24	24
		Mean	**86.48**	**98.68**	**0.21**	**81.38**	**94.17**	**0.197**
		SD	5.46	7.95	0.11	8.692	9.111	0.100
	Low	*N*	7	7	7	7	7	7
		Mean	**86.00**	**102.86**	**0.29**	**81.86**	**90.57**	**0.135**
		SD	5.97	11.48	0.16	4.811	6.347	0.083
Moderate	High	*N*	7	7	7	8	8	8
		Mean	**89.57**	**101.14**	**0.22**	**85.63**	**97.63**	**0.201**
		SD	10.75	14.57	0.14	5.502	6.948	0.066
	Moderate	*N*	23	23	23	23	23	23

		Mean	**87.48**	**97.17**	**0.17**	**87.52**	**97.61**	**0.171**
		SD	8.56	10.45	0.18	6.052	7.584	0.107
	Low	*N*	10	10	10	9	9	9
		Mean	**86.40**	**96.90**	**0.29**	**83.00**	**96.00**	**0.194**
		SD	5.32	9.89	0.10	13.528	10.137	0.139

Note: maximum ideal score 146; SD (standard deviation); N (the number of students)

Based on the data in Table 2, it is clear the modified MEA model with DE was better compared to the conventional model in improving students' mathematical disposition as seen from both school level and each of the students' PMA categories. The advantages of the modified MEA model with the DE were more obvious for students with high and low PMA categories at the high school level, in which the mean enhancements of the students' mathematical disposition were 0.31 and 0.29, respectively. For the modified MEA model with DE the students' highest mean of mathematical disposition was achieved in the indicator of "the ability to survive" with the measured aspects including: "I focus on working on problems whose solutions have not yet been found" and "I try again when I could not solve the problem correctly." The mean enhancement of both aspects, when viewed from Meltzer's classification (2002), is included under the medium category.

Next, students at the high school level with high PMA who were taught with the conventional learning model obtained an average enhancement in mathematical disposition of 0.11, whereas those at the medium school level with medium PMA obtained an average enhancement of 0.17. The lowest enhancement in mathematical disposition was achieved for the indicator of "Being responsible and risk-taking" with measured aspects including: "I set the way without considering the outcomes achieved" and "the grade that I gain is not comparable to the work I have done." The average enhancements of both aspects, in terms of the average N-gain, are included under the low category. Thus, the students who were taught with the conventional learning model achieved a greater enhancement in their mathematical disposition compared to those taught with the modified MEA model with DE. This finding is as seen in the results the post hoc test of One-Way ANOVA on the interaction effect between learning models, school levels, and PMA categories of the students on their N-gain mathematical disposition. Stacey (2013) said that people who develop the capacity in a particular field tend to be influenced by their habits of thinking and productive attitudes. Productive attitudes, in Sumarmo (2012) opinion, are positive attitudes and habits developed in viewing mathematics as being logical, growing confidence, and high metacognitive abilities.

1.5. The Interaction Effect between Learning Factors and Prior Mathematical Ability on Students' Mathematical Disposition

The two-way ANOVA test results for the interaction effect among the learning models and students' prior mathematical ability (PAM) on the enhancement of students' mathematical disposition are presented in Diagram 2.

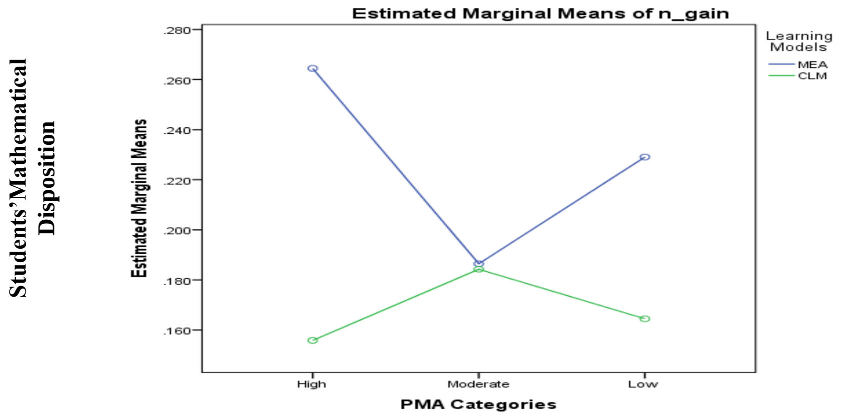

Diagram 2: Interaction among Learning Model and Students' PMA on Enhancement of Students' Mathematical Disposition

From Diagram 2, it can be seen that the mean line graph for the modified MEA model with DE for the experimental group students with high PMA category is higher than that of the low or medium category PMA students; the same is true for the mean line graph of the medium PMA category students compared to that of the low PMA category students. In addition, the mean line graph for the conventional learning model indicates that control group students with high PMA category was lower than that of the students with low PMA category with respect to improving students' mathematical dispositions. The mean of both line graphs shows that both learning models had a significant effect on the enhancement of students' mathematical disposition.

Although the two lines in the diagram do not intersect, they show that both the learning models and the three categories of PMA had a significant effect on the enhancement of the students' mathematical disposition. The distance between both lines in the diagram for each PMA category tends to be relatively different, and the lines do not intersect. This means that there was no significant interaction effect on the enhancement of mathematical disposition of the students based on the learning models and each category of PMA. This finding indicates that students with a high PMA category tended to benefit more from the modified MEA model with DE in their enhancement of mathematical disposition compared to the conventional learning model for the medium and low PMA categories. Thus, it can be concluded that the interaction effect between the learning models and the three categories of PMA resulted in a significant difference in the mathematical disposition of the students, but there was no significant interaction between the two learning models and the PMA category of students on the enhancement of the students' mathematical dispositions. The findings are in contrast to other theoretical and research findings. Goldenberg et al. (2009) reported that the habit of thinking mathematically has a close relationship to the success of each learner in learning mathematics. Students with high mathematical disposition show greater achievements and perseverance on difficult issues (Cuoco, 2010, p. 377).

CONCLUSIONS

Based on the results of data analysis, findings, and discussion the following things can be summed up.

(1). The MEA learning model developed by Glass & Holyoak (cited in Umar, 2011) has been modified by the researchers with DE through three stages: (1) Analysis of didactical situation conducted by the researchers prior to the trial of the teaching materials; (2) Metapedadidactical analysis conducted by the researchers during the trial of teaching materials; and (3) Retrospective analysis carried out after the trial of teaching materials. The modified MEA learning model with DE remains guided by the four principles of MEA learning: Syntactic principles, social system principles, heuristic principles, reaction principles of self-selection strategies, and the principles of support systems. During the initial activity using the modified MEA learning with DE, teachers ask a series of questions to determine the extent to which students have mastered basic mathematical concepts, which are associated with the materials to be taught. At the end of the lesson, the teachers assign the students the task of self-study and the making of a concept map of the materials to be taught at the next meeting.

(2). The enhancement of the students' mathematical critical thinking ability (MCTA) which received the implementation of the modified MEA model with DE was significantly higher than that of the students who were taught with the conventional learning model. However, there was no interaction effect between the modified MEA model with DE and prior mathematical ability (PMA) categories on the enhancement of the students' mathematical disposition.

(3). Students' MCTA could be improved more optimally by using the modified MEA model with DE compared to the conventional learning model. In this case, the indicators of students' MCTA that still need to be improved are: "students are able to provide further explanation", and "students are able to draw conclusions". Thus, it is expected that future researchers continue this research by focusing more on the two indicators of MCTA that had not been achieved by the students in this research.

(4). Finally, in terms of the scope of materials or mathematical concepts in junior high school for both school levels (high and medium) which can be represented figuratively in the findings; it can thus be said that the modified MEA model with DE is strongly expected to have good effect on students' MCTA and cultivate mathematical disposition with each PMA category.

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IMPROVEMENT OF STUDENTS' MATHEMATICAL CRITICALTHINKING SKILLS USING GUIDED DISCOVERY

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Abstract

This study aims to discuss an alternative theory that is suitable to be used to improve the ability of critical thinking mathematically learners using guided discovery. The ability to think critically is one of the highest-order thinking skills, a person capable of critical thinking, not only to solve problems, but also to make reasonable excuses for the solutions he provides, since basically thinking is the activity undertaken to reach a conclusion. One of the causes of the development of critical thinking ability of learners because during this time in learners tend to be passive and learners are less involved in finding concepts. Therefore it is necessary a way for teachers to increase the activity and critical thinking skills of mathematics through learning by using guided discovery. Guided discovery is a series of learning activities that emphasize critical and analytical thinking processes to seek and find their own answers to questions about problems with teacher guidance. The method used in this research is literature research that is by collecting data about guided discovery based learning on the critical thinking ability of learners from various sources such as relevant research, books, etc. After conducting literature studies by citing data from various sources it is suspected that guided invention can improve the ability of critical thinking mathematically learners.

Keywords: *Guided Discovery, Critical Thinking Ability*

INTRODUCTION

Mathematics is an important science base given in an early state. Given the importance of mathematics subjects should be given to all learners ranging from elementary school to college to equip them with logical, analytical, systematic, critical and creative thinking and cooperative skills (BSNP 2006: 345). According to Depdikbud (1991:1) one of the goals given by mathematics at the level of primary and secondary education is to prepare students to be able to "use mathematics and mathematical mindset in daily life".

Because by learning math, we will learn reasoning critically and actively. At the same time, we will observe the power of mathematics by cultivating the ability to learn to learn. So, to gain the power of mathematics in real life by facilitating the ability to think, liveliness and increased confidence in math.

Various efforts are made by the government to improve the quality of quality mathematics education, such as improving the quality of mathematics teachers, completing educational facilities and infrastructure, preparing student and teacher handbooks, and improving the curriculum. But the various efforts that have been done have not shown satisfactory results. This can be seen from many students get low score and not yet comprehend the concept of mathematical maximally.In research conducted by Tika (2014), learners who study mathematics is only guided by a book, so that students learn difficult to learn independently. The learning process still uses the lecture method where learners are passive and the educator is active.

In research conducted by Gezi (2016), states in the learning process that occurs in schools are more focused on the teacher. Learning process begins from the teacher explains the advanced learning materials provide examples of problem andat the end of the lesson provide training to leaners. Theproblem given by students is usually a matter of a routin matter, so it is difficult to solve the problem of varied question that require critical thinking. Such learning makes learners less active and not independent and alwayswaiting for answer from teachers. So that leaners only receive and are poorly trained in constructing or building their own knowledge in solving the problem of mathematics presented in the subj ect matter. Therefore, mathematics learning actvities like this do not show the critical thinking ability of leaners so that the leaners learning out comes are less saticfactory.

The solution provided for students' critical thinking skills is improved by providing a learning by using guided discovery. To produce active, easy-to-understand, and fun learning for students requires a learning model that enables students to actively participate in teaching and learning, a learning process that enables active student participation during learning and student interests can be created by learning to use the tools (Supriyono, Setiawan and Trapsilation, 2014). Developing learning devices based on guided discovery, based on the understanding that the discovery model is self-guided.

METHODS

This study included a type of literature study. Where literature study is the way used to collect data or sources related to the topic raised in a study. This study contains guided discovery and critical mathematical thinking skills.

RESULTS AND DISCUSSION

Based on the results of literature study, it is found that thinking learning is the utmost utilization and use of the brain to create a generation of superior nation. The ability to think critically is one of the highest-order thinking skills, a person capable of critical thinking, not only to solve problems, but also to make reasonable excuses for the solutions he provides, since basically thinking is the activity undertaken to reach a conclusion. To produce active learning, easy to understand, and fun for students requires a learning model that allows learners to actively participate in teaching and learning process, the learning process that enables the active participation of learners during the learning process and the interests of learners can be created by learning to use the device (Supriyono , Setiawan and Trapsilasiwi, 2014). According to Hosnan (2014: 342) dalam learning not only remember a number of facts, but learning is the process of thinking (learning how to think), namely the process of developing the potential of the entire brain.

Likewise, from this criticalthinking the need for an attitude of openess tothe idea of a new idea. Indeed this is not something that is easy,but should and still be implemented in an effort to develop the ability to think (Fisher, 2010). Learning thinking is the utmost utilization and use of the brain to create a generation of superior nations. The ability to think critically is one of the higher-order thinking skills, a person capable of critical thinking, not only to solve problems, but also to make reasonable excuses for the solutions he provides, since basically thinking is the activity undertaken to reach a conclusion.

This is in line with the statement of Hasratuddin (2009) in the Journal of Education and Practice Vol. 6 No. 24 which states that the ability to think critically is a person's ability to analyze, reflect the results of his thinking and draw conclusions based on reasonable and logical reasons. Meanwhile, according to Palinnusa (2013) critical thinking ability is a person's ability to identify problems, connect, analyze and solve math problems. Trilling and Fadel (2009) also states that critical thinking consists of the ability to analyze, interpret, evaluate, summarize, and synthesize all information.

From the above opinion, it can be concluded that the ability of critical thinking is the ability to think that has the characteristics of analyzing, synthesizing, recognizing and solving problems, and concluded.

According to Markaban (2006) in Journal of Education and Practice Vol.6, No.24, the guided discovery model is

(1) to formulate the problem that the student will provide with sufficient data;

(2) data provided by teachers, students prepare, process, organize, and analyze data;

(3) Students make guesswork (estimate) result of analysis done;

(4) if necessary, the allegations it holds have students examined by the teacher;

(5) alleged verbalization is also submitted to the students for compilation;

(6) Once students find what they need, teachers should provide additional exercises or questions to check whether the findings are true.

The National Research Council (Sunismi and Nu'man, 2012) states, the guided discovery model is a series of learning activities that emphasize critical and analytical thinking processes to seek and find their own answers to questions about problems with teacher guidance. From the above description, it is concluded that guided discovery model is a learning model that presents a problem or question that makes learners can think, observe, make guesses, explain, and analyze to seek knowledge with guidance and instruction from teacher.

CONCLUSION

Mathematical critical thinking ability can be seen using guided discovery models. The ability to think critically is the ability to think that has the characteristics of analyzing, synthesizing, recognizing and solving problems, and concluded. The guided discovery model is a learning model that presents a problem or question that allows learners to think, observe, make guesses, explain, and analyze to seek knowledge with guidance and instruction from the teacher. Thus it can be seen that in order to improve the critical thinking ability of mathematic learners we can use guided discovery model in the learning process.

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THE DEVELOPMENT OF GUIDED DISCOVERY BASED LEARNING TOOLS ALONG WITH MIND MAP TO IMPROVE MATHEMATICAL COMMUNICATION ABILITY OF THE VIII SMP

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Abstract

This research to development guided discovery based learning device with mind map that can improve mathematical communication ability of the learners, and to kow the feasibility of the device that has been developed according to experts, techers and students of junior eigh schools pariaman. Research method used is research and developmend (R&D) by applying a model of plomp development that begins from the preliminary stage, prototype development stage and assessment phase. Device developed in the form of RPP and LKPD. The subject of the student to class VIII junior eigh school 7 pariaman. Data collection by documentation study, interview and questionnaire techniques. Data from observation, Questionnaires and test were analyzed quantitatively reinforced with the result of documentation analyzed descriptively qualitative. The result of research based an data obtained showed that the mathematics learning exparatus produced meet the valid categories,practical and effective both in terms of the feasibility and validity of the validatore validation test wich states that the learning role developed has been validbased on the content, contructs and the corresponding language of EYD. practicality is know from the result of one-to-one, small group and field test. Affectivenes obtained from small group, field tes.This research ca be conlueded that the learning tool of mathematics deserve to be used as reference material in learning mathematics especially mather of building of flat side room of class VIII SMP.

Keywords: *Guided Discovery Learning And Mind Map.*

INTRODUCTION

Education is one of the transformation of learning culture that plays a very important role, because education is a vehicle to improve and develop human resources. Through education is believed to be able to encourage and maximize the potential of learners as a reliable and qualified human resources, which can behave educated, critical, creative, logical and innovative. Therefore all efforts should be made to improve and improve the quality of education.

Mathematics is a branch of science that plays a very important role, to develop the ability of critical thinking, creative, logical and innovative learners (Russefendi, 1991). [1] Because in learning mathematics learners are not only taught to simply memorize mathematical formulas, but learners must also use mathematics to solve problems that exist around them. therefore the learning of mathematics is taught in every level of education. The abilities to be achieved in NCTM mathematics learning include problem solving, reasoning, communication, pattern search or connection, and representation. "[2]

Of the five capabilities mentioned by the NCTM, communication skills include one that should be a concern and should be mastered by learners.

The ability of mathematical communication is needed in the learning of mathematics, because by having good mathematical communication ability then students will be able to write symbols, read diagrams and graphs, and will help students to solve the existing problems (Huang, 2009) [3]. But in the field encountered many learners who are not able to communicate his idea well. Learners like lack of words in conveying the idea. This is not only experienced by learners with low ability but also experienced by smart learners. They can answer or solve the given problem correctly, but are unable to explain or write it well. The writing he made was only understood by himself.

Low communication ability of learners is due to learners not yet accustomed in solving problems that measure communication skills. Based on research reports from some researchers, the low ability of mathematical communication of learners is felt in many schools throughout Indonesia, such as research conducted by M.Rezki Putra in 2016 at SMP 35 Padang, SMPN 20 Padang, SMPN 34 Padang [5]. Yerizon's research in 2015 on grade IX Man Salido student in the southern coastal area [6], even outside the West Sumatera region also felt it as stated in Edy Tandailing's research which was conducted on high school students of Pontianak class X 2011 and [7] Conducted by Alvan Marali (2013) at SMPN 1 Kabila Bone Gorontalo [8]. To prove the truth of the previous research opinion the researcher did observation of school at junior high school / Mts level in pariaman. From the observations made the researchers also see the mathematical communication skills of learners included in the low category. This can be seen from the results of communication skills tests that researchers do on November 7, 2016 on students of class VIII SMPN 7 Pariaman and students of class VIII MTS 1 Kota Pariaman. Based on the results of communication skills tests on indicators connecting real objects, images, into the idea of mathematics SMPN7 Pariaman who no answer as much as 87% while MTS 1 students as much as 77%. For the indicator explain the idea of mathematics students SMPN 7 who answered correctly 17% while MTSN Padusunan students only 23% rest no answer. If seen again from the indicators of students' ability to declare daily events into the symbols of mathematics, students SMPN 7 Pariaman get a score of 2 which means 13% correct answer and MTSN Padusunan students only 10%, the rest have no answer. This means showing the low level of mathematical communication ability of class VIII students.

The lack of communication ability of learners is caused by several things such as, the learning method used is still not support the learners in honing their communication skills, as well as the learning tools used are also less facilitate learners to learn actively communicate their own ideas. Learning tools in question are RPP and LKPD.

The RPP used by the teacher is an RPP designed based on subject teachers' consultation(MGMP). From the observations made by the researchers see in the learning process the teacher can not implement the learning in accordance with the RPP designed, this is because the RPP has been designed not in accordance with the conditions and environment of learners, and core activities in the RPP is still not detailed. In addition to the use of RPP that supports the learning process.

LKPD also plays a role in supporting learners improve the ability of mathematical communication. Because the activities in the LKPD will train learners to discover their own concepts and knowledge about the material being studied. From the results of literature study that researchers do, researchers see that LKPD used by learners is still less effective in improving communication skills, this is because LKPD used already directly presents a summary of the concept of the material, then learners are asked to do the exercises. Such activity is one of the causes of low communication ability of learners.

Based on the description of the above problems, then to overcome these problems researchers do research development of learning tools in the form of RPP and LKPD with selected learning model that is guided discovery model. According to the theories and the results of research done by previous researchers, guided discovery models can enable learners in the learning process, as well as learners can construct their own thoughts and ideas. This can be seen from the results of previous research ie Rizki Rahman (2014) [9], Purnomo revelation (2011) [10], Khomsiatun Siwi (2012), Asrul Karim (2011) [11], Yusnita Rahmawati (2014) 12], Alfieri l (2011) [13] However, in the process of finding the learners are often constrained in connecting a concept with other concepts, this is because learners often forget the material that has been studied, therefore researchers try to combine This guided discovery model with mind map making at each end of the material has been studied.

Mind map is a powerful graphic technique that provides a universal key to unlock the full potential of the human brain so that it can utilize all the capabilities that exist in both hemispheres such as word, image, number, logic, color, in a unique way (Buzan, 2007) 14]. In line with that Taufik (2011: 349) also explained that Mind Map is a graphical technique that can provide ease in thinking and remembering and improving the recording, which usually in the form of words or numbers, sentences, pragraf [15]. Mind-minded learning has also been applied by some researchers such as research conducted by Rahma Faelosofi (2016) [16], Sri Indriati Hasanah (2013) [17], Rezki Ramdhona (2014) [18], Sri Adelia Sari (2016) [19] from their research obtained results that the use of mind map in the learning process can improve student learning outcomes. Based on expert opinions and previous research reports it can be concluded that the use of mind map in learning can help students clearly and creatively identify what they have been, are and will learn, so using Mind Map will familiarize learners to be able to communicate thinking and understanding they are against matter through writing.

Learning Device Development is done for class VIII SMP semester 2. But in the trial is only done on one material that is the matter of building a flat side space. The material of building flat side space is a matter of geometry. Geometry is a field of science that is very close to the environment of learners, almost all the objects that exist around the learner is a scope of geometry problems. Seen from the results of tests conducted researchers see still many learners who have difficulty in solving problems related to the field of geometry. Therefore, for the experiment, the researcher did the material on the flat side room.The formulation of the problem developed in this research is How are the characteristics of learning based on guided discovery along with mind map to improve the mathematical communication ability of junior high school students of class VIII that meet the valid, practical and effective criteria?

RESEARCH METHODS

This type of research is a combination of research development and experiment. The development model used is the Tjererd ploom development model. The Plomp model consists of three stages: preliminary research, prototype development or prototyping phase, and assessment phase [24].

The preliminary research phase is a preparatory stage consisting of needs analysis, curriculum analysis, and concept analysis. Phase development or prototype (development or prototyping phase) is a process of designing and developing learning devices gradually through formative evaluation stages to evaluate and improve the prototype developed. The assessment phase "is an evaluation to test whether the final prototype or product is consistent with valid, practical and effective criteria. To obtain an effective product, experimental research is conducted, with the form of Posttest Only Control Design design. The instruments used for data collection are as follows:

1) The validation sheet, to collect data on learning device validation results.
2) Interview guide, used to collect student opinion data and teacher's opinion on the use of learning device at one-to-one stage.
3) Observation sheets, to collect data on learning practicability, especially the usability and implementation of the compiled device.
4) Questionnaire response students and questionnaire teacher response, to see the practicality of the use of learning tools
5) Tests Communication skills are used to see the effectiveness of learning tools in improving the mathematical communication skills of learners

RESULTS AND DISCUSSION

1. Preliminary Reseach Results

Activities undertaken at the preliminary stage of this research is Need analysis, curriculum analysis and concept analysis.

Needs analysis is done to see what is needed by teachers and learners. Based on the analysis of needs that researchers do from 7-8 November 2016 in SMPN 7 Pariaman with the instrument used in the form of questionnaires and interview guidelines obtained the result that teachers and learners need new innovations in learning mathematics in the form of RPP and LKPD that can support the smooth process of learning. The required RPP is adjusted to the level of student ability. And the required LKPD contains activities and exercises that can help learners communicate their thoughts and ideas. Besides that required LKPD made with attractive color display.

The curriculum analysis aims to study core competencies, basic competencies, indicators, material coverage and learning objectives. Based on the analysis of the curriculum, there is a description and development of indicators of the basic competencies that have been determined. At KD 3.10 differentiate and determine the surface area and the volume of the rise of flat side space (cubes, beams, prisms, and limas) at the beginning contains four indicators of achievement of competence more elaborated into 8 indicators, namely: 1) identifying elements of wake up flat side space, 2) Drew the nets of a flat side room. 3) determining the surface area of the surface of the flat side room, 4) calculating the surface area of the flat side room, 5) determining the volume formula of the flat side room space of some activities, 6) calculating the volume of wake up flat side space 7) Flat side if known volume of wake up flat side space, 8) calculate the volume of wake up flat side space if known surface area of wake up flat side space. In KD 4.10 there is no addition of indicators, the indicator used is an indicator that already exists.

Conceptual analysis is the identification of materials that will be needed on the development of learning devices. These materials are arranged systematically by linking a concept with another relevant concept to form a concept. The material of the flat-side building is presented in the cube material for two meetings, the first meeting discussing the width of the surface and the second meeting of the volume, then the third meeting of the surface area Beam, the fourth meeting of the beam volume, the fifth encounter of the prism surface area, the sixth meeting of the prism volume, the seventh meeting of the pyramid surface area and the eighth meeting of the pyramid volume.

Based on the results of the preliminary stage analysis, a learning device based on guided discovery model with mind map was developed. Furthermore, the device is self-evaluated (self evaluation) and validated by experts (expert review). After a learning device based on a guided discovery model along with a valid mind map, to see the practicality and effectiveness of the learning model, one to one evaluation, small group evaluation, and field test were conducted. Field tests conducted on students of class VIII6 SMPN 7 Pariaman

2. Phase Prototyping Results
a) Prototype 1
a.1 Designing RPP

The Learning Implementation Plan (RPP) is designed to guide teachers in delivering learning materials. The RPP component is designed based on Permendiknas no 22 of 2016 on process standards for primary and secondary education units. The learning activities presented are integrated into LKPD-based guided discovery along with mind map. Presentation of RPP, Core Competency, Basic Competence, Indicators, Learning Objectives, Teaching Materials, Time Allocation, Learning Resources and Assessment are similar to RPP in general. The RPP components that are characteristic of this guided Discovery RPP model are:

1) Writing learning objectives

Writing learning objectives in RPP commonly used by teachers who directly mention the purpose in general, did not mention the form of activities undertaken as through this learning is expected students are able to calculate the surface area of the cube. Learning Objectives expected in the RPP is designed through the existing activities 2 In LKPD learners can calculate the surface area of the cube. Once so on the writing of learning objectives should be clear its activities and implementation to learners and the benefits to be achieved by learners.

2) Core activities

Implementation of core activities is tailored to the guided discovery learning model with mind map, where in the stimulation phase learners are asked to look at the illustrations of the stories present in LKPD, then learners are asked to pay attention to the context of the problems contained in LKPD, then through the questions that are in LKPD learners can identify problems, then learners write answers from each question where available as a form of learners activities in collecting information, from information collected learners are asked to process information by paying attention and connecting each answer that has been written. Through the discussion with friends or with other groups learners are asked to check back or verify the correct answers made. then learners are asked to conclude their understanding of the concept that has been learned by writing it in the form of mind map. For the next meeting the mind map created by learners starting from the mind map created at the previous meeting continued on the mind map of the ongoing material

3) Closing activity

At the closing session, several group representatives were asked to present the group discussion result in the form of mind map.

a.2 LKPD Design

LKPD based Guided discovery with Mind map created using Microsof Word 2008. LKPD has several components covering Title contained in Cover, study guide, compotence to be achieved, problem, activity steps, and training. LKPD has interesting Images in accordance with the problem to be solved in finding the concept of the material being studied, some of the images contained in LKPD are taken from the Internet

Presentation of material on LKPD at the first meeting presented Mind map first, the goal is to facilitate learners in connecting a concept of material that has been studied with the material to be studied. Presentation of the material begins by providing stimulation or stimulation to learners through the experience often encountered in everyday life, with the aim to stimulate the interest of learners following the learning process. Learners are asked to solve the problems given through a trial activity. Based on experiments conducted imana learners are guided to identify problems through questions that must be answered so that learners can find their own concept of the material, and can make their own conclusions. End of learning learners are asked to communicate their own understanding of the material that has been learned by writing it in the form of mind map place available. Mind map presented at the beginning of the meeting on LKPD 1 can be seen in Figure 5 below.

b) Prototype 2

After RPP and LKPD designed self-evaluation conducted by the researchers themselves. Self evaluation conducted on RPP to see the completeness of RPP identity, formulation of indicators, formulation of learning objectives, material selection, correctness of guided discovery stage, correctness of mind map writing in guided discovery stage, selection of learning resources, and assessment. While the self evaluation on LKPD aspects that are seen are the accuracy of typing, the accuracy of the use of words and terms, the accuracy of the use of punctuation, the accuracy of text size, the accuracy in the placement of images, the availability of empty space to solve problems and make conclusions, material accuracy of guided discovery steps . In general, many errors occur in typing words and punctuation. Punctuation errors for example, after punctuation are not spaced 1 spaces, lack of punctuation, capital letters after the dot. In LKPD there are typing errors, lacking letters, poor punctuation, and some questions in LKPD are using the word "Ananda" and "You" so that the word "You" is changed to "Ananda". After the self evaluation is done then the revision is done, the revision result is called Prototype II

C) Prototype 3

After RPP and LKPD revised validation by experts, RPP validation is done by 4 experts, namely 3 lecturers of mathematics, 1 lecturer of Indonesian language. Aspects assessed by the conformity of RPP components with the 2013 curriculum component, suitability of activities with guided discovery model with mind map, language suitability with EYD rules. Suggestion from Validator is the formulation of indicators in the RPP adjusted to the basic competencies that have been. another suggestion from the validator is to write the form of activities that exist in LKPD at each stage of guided discovery in the core activities. After the revision in accordance with the suggestion of the validator and discussed again, then revised again so that obtained a valid RPP. The result of RPP validation is RPP component with average 3.58, Learning activity with average 3.42, and language with average 3.5 so that the average total validation for all three aspects is assessed is 3.5 with very valid category.

Similarly, LKPD Validation RPP is conducted by 5 expert lecturers. 3 lecturers of mathematics, 1 lecturer of Indonesian language, 1 lecturer of education technology.

Validation is done repeatedly, where every revision done according to the validator's suggestion is discussed again with validator in question until obtained by valid LKPD. Aspects that are assessed on LKPD-based guided discovery with mind map are: Didactic or presentation aspects, content and material aspects, language aspects, and aspects of kegrafikan. Validation results from the four aspects viewed obtained average total validation is 3.43 with valid category.

RPP and LKPD that have been valid can be used to perform practicality test and efketifitas in the next stage. The valid RPP and LKPD are called prototype 4.

D) Prototype 4

Prototype 4 that has been obtained then conducted individual trials called with one-to-one. One-to-one results in LKPD found that the clues contained in the LKPD were sufficiently clear. For LKPD 1 to LKPD 4 meetings there are no constraints, there is little improvement in terms of writing, however in LKPD 5-8 learners have difficulty identifying and gathering information. LKPD 5 to LKPD 8 is revised by adding several questions to make it easier for learners to identify and gather information.

Data collection to see Mathematical communication ability of learners at one-to-one stage is taken based on the observations made from the learners activities in doing the exercises that exist in LKPD, at the first meeting for high-ability students have been able to identify the problems properly, and the use of the symbols and the size is right and the problem solving is also correct, so for the indicator of communication ability that is seen is good, but for the lesser students with low-ability and moderate, at this first meeting the communication skills of learners still not in accordance with measured indicators, through Guidance and direction of the researcher, low and moderate learners at the second meeting have begun to increase, and so on for the third and fourth meetings. Based on the work done from each meeting, it can be concluded that LKPD based guided discovery with mind map at one-toone stage is effective.

The implementation of one-to-one RPP-based discovery is guided by providing RPP for 8 meetings to one of the SMPN 7 mathematics teachers. The researcher asks the teacher to read and examine the RPP that has been designed, then the researcher asks for suggestions for improvement of RPP. Based on the advice of the teacher revision of the RPP has been designed.

E) Prototype 5

After the implementation of one-to-one prototype 5, then small group evaluation of the prototype. in this small group evaluation, it is tested by practicality and effectiveness test. this trial is done to 6 students with different levels of ability. Practicality test is done by researcher using RPP and LKPD in learning process.

Instruments used to see the practicality of LKPD in the form of observation sheet of the implementation of RPP filled by 2 people observer that is the researcher himself and one of the math teachers. Based on the observation sheet the implementation of RPP obtained practical level about 80% with practical criteria. While the instrument used to see the practicality of using LKPD is 92.25% questionnaire with practical criteria. Test the effectiveness of the test of communication skills, based on the results of communication skills test obtained only 1 student who is not complete. After the implementation of small group test done some revisions to RPP and LKPD, then the revision of RPP and LKPD is called with prototype 6.

F) Prototype 6

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Universitas Negeri Padang, West Sumatera Indonesia
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The resulting prototype 6 was then tested by a large group, this large group was done classically on the students of class VIII.6. The large group test aims to test the practicality and effectiveness of the product. Practicality test is done by using RPP and LKPD in learning process. Instrument used to collect information in the form of observation sheet of RPP, teacher questionnaire response and questionnaire response of learners. Based on the observation sheet of RPP is obtained practicality level 78.13% with practical category. This means that the RPP can be said to be practical and can be used, then viewed from the questionnaire teacher response and questionnaire response learners obtained the sequential percentage of 87.5% and 79.91% This means that LKPD used is practically practical, but in LKPD there are some revisions, LKPD 6 which contains questions that answer the same, selected one of them only. After the device is revised, the device is called prototype 7. LKPD guided discovery along with mind map obtained after prototype development can be seen in Figure 1.2,3,4,5 below.

Gambar 1: Tahap Stimulation Pada LKPD 3

The Stimulation Stage in Figure 1 is an activity in which the teacher provides a stimulus about the understanding of the surface area of the beam. Stimulus given in the form of story illustrations, in the picture there is a box on the outside covered by wrapping paper, learners can calculate how many wrapping paper needed to wrap the box. If learners find how much wrapping paper is needed to wrap the box it means learners are looking for the surface area of the beam. Based on the illustrations of the story it is hoped learners can understand what is meant by the surface area of the beam and the object of building another flat side space.

Kotak yang masing-masing kelompok pegang berbentuk balok berukuran panjang 25 cm, lebar 20 cm, dan tinggi 15 cm. untuk menyelesaikan kasus ini, ananda harus menggunting kotak tersebut pada setiap sisinya, kemudian gambarkan setiap bangun datar yang terbentuk dari hasil pengguntingan kotak dan tuliskan ukurannya, serta isilah kolom yang berisi pertanyaan di bawah ini :

Gambar 2: Tahap Konteks masalah Pada LKPD 3

The phase context of the problem in Figure 2 is the problem given to the learner so that learners can find their own surface area of the beam. From the size of the beam provided, students are expected to be able to calculate the surface area of the beam.

2. Berbentuk bangun datar apakah sisi dari kotak kado diatas? Bagaimana cara menghitung luasnya

3. Berapa jumlah sisi dari kotak kado diatas

....

....

....

....

....

4. Nyatakan bagaimana cara mencari luas keseluruhan sisi dari kotak kado tersebut

....

....

Gambar 3: Tahap Mengumpulkan Informasi

The Gathering stage of information in Figure 3 is an activity in which learners can identify the problem from the context of the given problem and then the information obtained from each question item is written down in the available place.

31

Mengolah informasi

5. Berdasarkan pengetahuan yang telah ananda dapatkan pada pertemuan sebelumnya dalam mencari luas permukaan kubus, carilah luas kertas kado yang dibutuhkan untuk melapisi kotak kado diatas

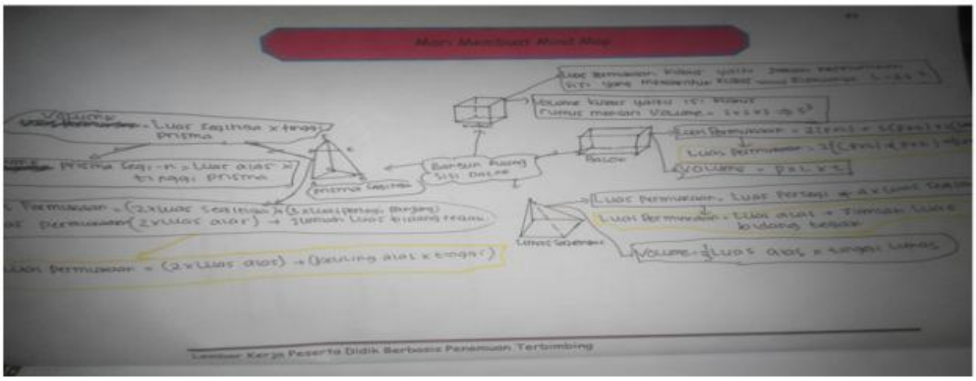
....

....

....

Gambar 4: Tahap Menyimpulkan Informasi

The process of processing information in Figure 4 is an activity in which learners process the information collected so that learners can calculate their own beam surface area against the size of the beam given to the context of the problem. From the results obtained calculations are expected to learners can conclude their own formula used to find the surface of the beamAfter all the learning process using RPP and LKPD based guided discovery with the mind map ends. To strengthen the learner's knowledge of the building material on the flat side, the learners are asked to make a mind map from the beginning of the meeting until the end of the meeting. Here's an example of a mind map created by one of the learners can be seen in figure 5.



Gambar 5: Mind Map Yang Dibuat Oleh Salah Satu Peserta

3. Result of Phase Assessment

The prototype 7 that has been generated is then carried out by the phase assessment test to see the practicality and effectiveness of the actual device. This test is done by using two classes: experimental class and control class. The experimental class is a class that uses a guided discovery-based device with a mind map in the learning process, whereas in the control class does not use a guided discovery-based learning device with a mind map, but at the end the material is tested for the same communication skills test. Based on the results of practicality test against LKPD using questionnaire teacher response and questionnaire response learners obtained the sequential results are 89.46% and 79.91% are categorized practical. Based on the observation sheet the implementation of RPP obtained 80.4% results with the practical category.

Effectiveness test is done by comparing the two sample classes, because the two sample classes are not normal then tested mann_whitney. Decision-making by looking at probability numbers, provided that accept H0 if probability value> 0.05 and vice versa reject H0 if probability value <0.05. Because the number in the ASYMP column. Sig (2-tailed) is 0.000. which is less than 0.05, thus H0 is rejected. This means that there is a difference in the communication skills of learners in the Experiment class and Control class. Based on the exposure Mann Whitney Test it can be concluded that the use of learning devices based on discovery guided with the mind has been effective in improving the communication skills of learners. After the field test there is little revision in LKPD while in the RPP there is no revision. After the RPP and LKPD were revised, the learning tools were valid, practical and effective

CONCLUSION

This research is a development research that produces guided discovery based learning device with mind map. The device is in the form of RPP and LKPD for class VIII mathematics material on Bangun Ruang Ruang flat side. From the results of the development can be concluded that the form of learning devices based on math discovery along with a valid mind map is a learning device in which already based on the discovery of guided mind map.

The form of learning-based math-based learning tools with a practical mind map is a learning tool that allows teachers to apply the steps of existing activities in the RPP in accordance with the time set. For learners, LKPD can improve their motivation and construct their own knowledge through the steps of activities in the LKPD. And learners can make a mind map of the material presented and learners can use the mind map in connecting one concept with other concepts and can as a reminder for learners of the material that has been studied

The form of guided learning-based math learning tools with an effective mind map is a tool in which RPP and LKPD can direct learners to positive activities and minimize negative activity. In addition, learning outcomes after the use of this learning tool already meets the minimum mastery criteria.

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DEVELOPMENT OF PROJECT BASED LEARNING (PROJECT BASED LEARNING) LEARNING MATHEMATICS ON MATERIALS FIGURE SIDE FOR STUDENTCLASS VIII SMP/MTs BATUSANGKAR

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Abstract

This paper describes the results of research on the development of mathematics learning devices that are characterized by project-based learning. The existing mathematics learning tools have not encouraged students to participate actively in learning mathematics. So students are not motivated to learn mathematics in using these learning tools. Researchers want to develop a device of learning mathematics, learning tools developed is a learning tool based mathematics Project Based Learning (PjBL) on the material Build Space. The purpose of this study is to determine the process of design, validation and practicality and the effectiveness of learning tools based on Mathematics Project Based Learning (PjBL). The research type is Research & Development with Plomp research design, preliminary research phase, prototyping phase (phase of manufacture and development of prototype), and assessment phase (assessment phase). Population and sample in this research is student of class VIII SMP / MTs Batusangkar. The results showed that the learning tools based on Project Based Learning (PjBL) are valid. This is indicated by a validation sheet score analysis with an average of 4.11. After analyzed the score of questionnaires the response of students' practice of students has a range of 77.00-86,00. Learning tools show ease / practicality in learning mathematics. Thus, it can be concluded that the learning tools based on Project Based Learning (PjBL) mathematics is very valid, practical and effective.

***Keywords**: Project Based Learning, Problem-solving Ability, Build a Flat Space Room*

PRELIMINARY

National education, as one of the national development sectors in the effort to educate the life of the nation has a vision of the realization of an educational system as a powerful and authoritative social institution to empower all Indonesian citizens to develop into qualified human beings capable and proactively respond to the challenges of an ever-changing era. In preparing students for the challenges of the future, the Ministry of National Education (MONE)publishes the Curriculum.

One of the areas of science to be achieved is mathematics. In the Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 65 year 2013 on Standard Process of Primary and Secondary Education, namely: Learning process in education unit held interactive, inspiration, fun and challenging, motivate learners to participate actively and give enough space for initiative, creativity and independence according to talent, interest and Physical and psychological development of learners.

To encourage the creation of interactive learning, inspirational, fun and challenging, motivating the learners is required Learning Tool. However, based on observations of researchers in the field, Learning Devices used have not been able to make students motivated and active in learning. So that the desired learning process has not been done properly.

Based on the writer's analysis of Mathematics Learning Tool used by teacher of class VIII SMP Batusangkar, Learning Device used in the school, Learning Tool has not been practical in terms of content or presentation. So it has not encouraged students to participate actively in learning. Teachers still use teaching materials in the form of a printed book that is Erlangga book. Teachers has tried to make Devices and LKPD that can summarize the subject matter from various books, but because of busy only occasionally the teacher can make LKPD. LKPD made only consists of 1 material or 1 meeting only. The teacher has never used a project-based Mathematical Learning Tool. From the above problems, learning tools have not been motivating and encouraging and have not helped students to solve mathematical problems. It is necessary to develop a Mathematics learning tool in which there is a project-based learning model. Devices developed in the form of RPP, LKPD, and Intrumen assessment. In accordance with Government Regulation No. 65 of 2013 on Standard Processes of Basic and Intermediate Education which implies that teachers as educators to develop the Lesson Plans (RPP). Thus, every educator is obliged to develop learning tools including RPP, LKPD and evaluation tools that are complete and systematic so that learning takes place interactively, inspiration, fun, so as to motivate learners during the learning process take place.

Learning tools developed should help students in mathematical problem-solving skills. The problem in KBBI (2008: 883) is defined as something to be solved or solved. A question will be a problem only if one does not have certain rules / laws that can immediately be used to find answers to the question (Hudojo, 2005: 123). Furthermore, the problem according to some mathematicians is a question that must be answered and responded, however, not all questions will automatically become a problem immediately.

A question will be a problem if the question indicates a challenge that can not be solved simply by using a routine way or procedure that the learners already recognize. In the learning of math each assignment for learners can be classified into two things, namely exercise andproblems.Based on the description, then the problem in mathematics is an issue that must be solved or solved by using an uncompleted settlement procedure in which the settlement step must be processed by the learners themselves.

After knowing what is the problem, then we will discuss about the problem solving. Problem solving is the process of applying the previously acquired knowledge into an unfamiliar new situation.

Problem solving is also defined as trying to find a way out of a difficulty, reaching a goal that is not immediately achievable. Because problem solving is a high level of intellectual activity. Problem solving in mathematics includes the process of finding answers to questions that require procedures or steps that are not routine and are present in a form of text, non-routine puzzles and real-life situations (Hudojo, 2005: 74). The learning objectives in the 2013 curriculum (Permendiknas no 58, 2014) state that the indicators of achievement of problem-solving abilities, including.

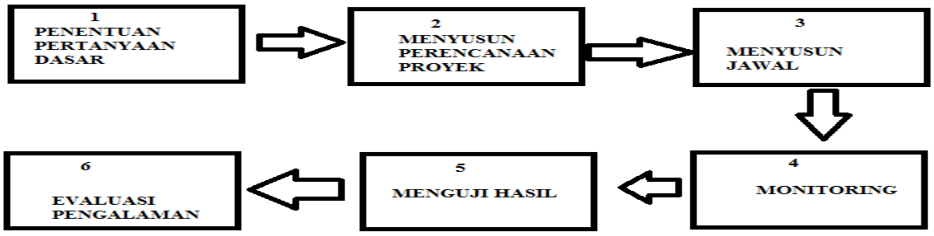
A.Understandthe problem

B.Organize data and select relevant information in identifying problems

C. Present a problem formulation mathematically in various forms
D. Choose the right approach and strategy to solve the problem
E. Use or develop problem-solving strategies
F. Interpret the results of answers obtained to solve problems

One of the learning models that can improve students' mathematical problem solving abilities is a project-based learning model. Project-based learning models can stimulate motivation, process, and improve student learning achievement using problems related to certain materials in real situations (Rais, 2010). In project-based learning the given problem is a context for students to learn about critical thinking and problem-solving skills and acquire essential knowledge and concepts from subject matter (Nurhadi, et al., 2004). In the process of solving problems, students can exchange opinions and work together so that the mastery of the material increases and finally students are able to achieve optimal learning outcome.

Project-based learning is an innovative learning model that focuses on contextual learning through complex activities. Buck institute for Education (in Sutirman 2003: 43) states that project-based learning is "A systematic teaching method involving students in learning knowledge and skills through structured processes, real-time and meticulous experiences designed to produce products"Ministry of Education and Culture (2014: 47) The steps of implementation of Project-Based Learning can be explained by the following diagram:



Explanation of project-based learning steps,
A. Determination of the Basic Question (Start With the Essential Question). Namely the question that can give the assignment of learners in doing an activity.
B. Designing the Project Plan (design a Plan for the Project) Planning is done collaboratively between teachers and learners.
C. Arrange Schedule (Create a Schedule). Teachers and learners collaboratively arrange an activity schedule to complete the project.
D. Monitor the Students and the Progress of the Project. The teacher is responsible for monitoring the activities of the students to complete the project.
E. Test Results (Assess the Outcome). Assessment is done in measuring the achievement of standards, play a role in evaluating the progress of each learner.
F. Evaluate the Experience. Teachers and learners reflect on the activities and results of projects that have been run.

In accordance with the project-based Learning step begins with fundamental questions, designs project planning, schedule, monitoring, assessing results and reflection. So the steps of this project-based learning model in accordance with the indicators of problem-solving capability that students understand the problem, organize the data, make the formulation and appropriate strategies for problem solving and interpret the results obtained answers to solve problems.

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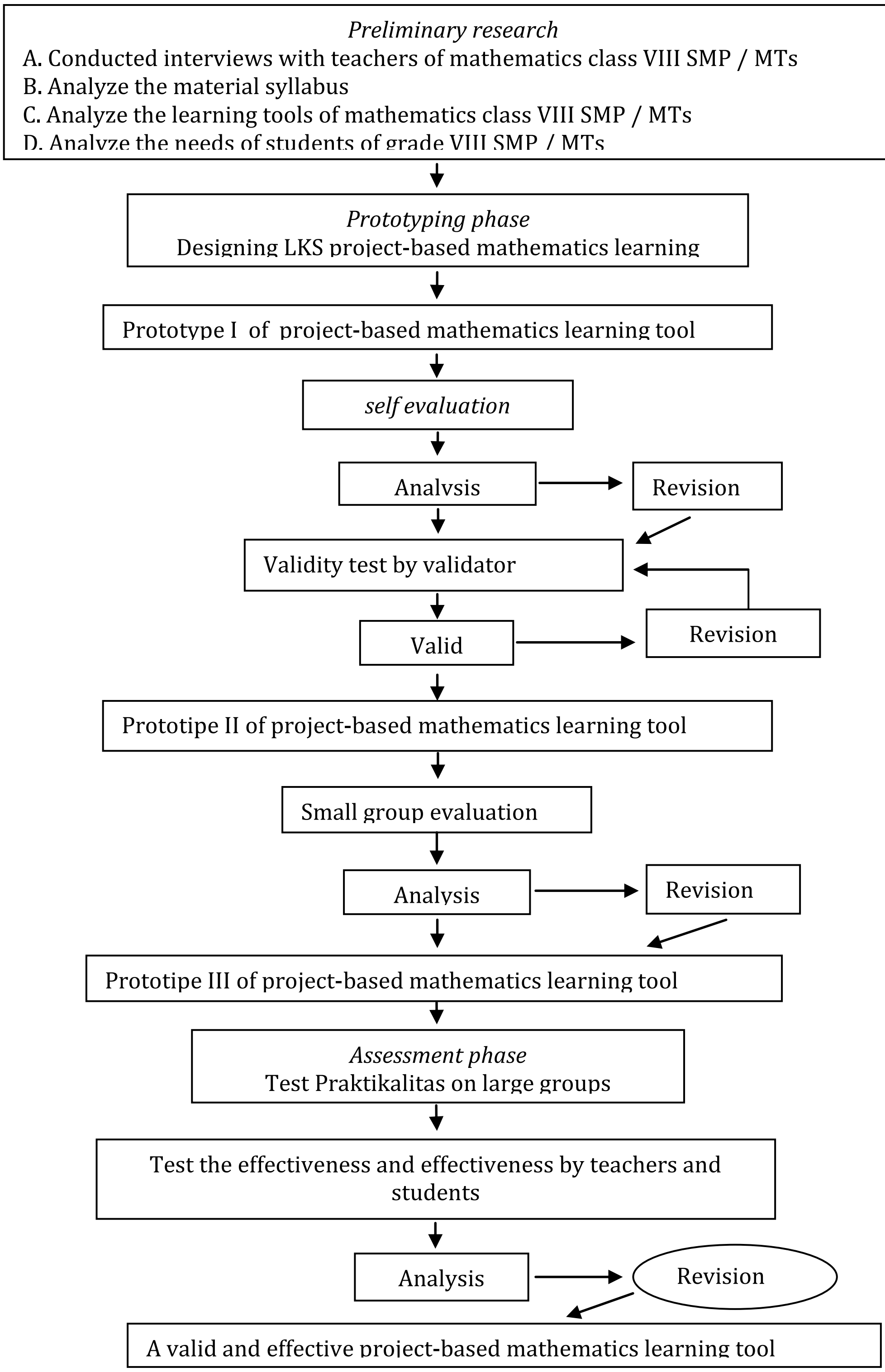
METHODOLOGY DEVELOPMENT

The type of research used is research and development or Research and Development (R & D). The project development model of project-based mathematics learning using the Plomp model. This model was developed by Tjeerd Plomp. According to Plomp (2013: 19) this model consists of 3 phases of preliminary research, prototyping phase, and assessment phase.The steps of the development of project-based mathematics learning tools are illustrated as the following diagram:



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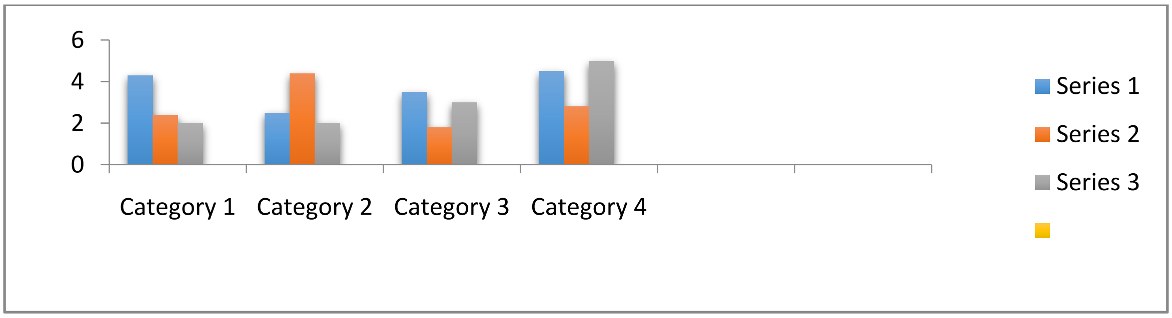
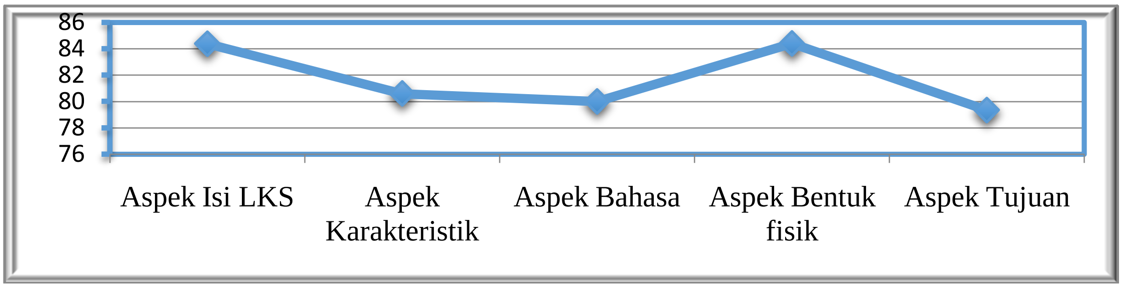
RESULT OF DEVELOPMENT

A. Preliminary research results
This stage is to define and define the requirements required in the development of a project-based mathematics learning tool on the building material.
1) Conducting interviews with grade VIII mathematics teacher
MTs
2) Analyze the material syllabus waking up
3) Analysis of learning tools of mathematics class VIII SMP / MTs.
4) Analyze the needs of students of grade VIII MTs
B. Results Phase manufacture and development prototype (prototyping phase
The purpose of the phase prototyping phase is to design a project-based mathematics learning tool that contains material in accordance with the basic competencies and learning objectives that have been determined. The design process of this device are:
A. Designing RPP, LKPD and Assessment Instruments that contain project tasks, project implementation steps and self-training and key answers.
B. The device is designed according to the time allocation contained in the syllabus ie 3x4 lesson hours (6 meetings).
C. Assessment phase (Assessment phase)
Design results at this stage produce prototype 1, then self-evaluation and expert or expert judgment are performed.



Graph of tabulation results Validation Sheet Validation of Project Based Learning Tool

After a revision of the project-based mathematics learning tool based on small group evaluation, field trials were conducted in one class.
1. Practical Results
A) Questionnaire result of student's practicality response
Based on the result of questionnaire of student's practicality response, it can be seen that practicality value ranges from 77,00 - 86,00. Thus the learning based mathematics tool based on Project Based Learning (PjBL) is stated practical from aspect of use and benefit.



Graph of tabulation results Validation Sheet Validation of Project Based Learning Tool

CONCLUSION

A. The process of designing learning tools based on Project Based Learning (PjBL) mathematics on building materials begins with investigating initial problems, analyzing student needs and performing syllabus analysis.
B. Learning based mathematics tools based on Project Based Learning (PjBL) on waking material is categorized as valid.
C. Learning based mathematics tool based on Project Based Learning (PjBL) on building materials has practicality / ease in learning mathematics.
D. Learning based mathematics tools based on Project Based Learning (PjBL) on waking materials have effectiveness in learning mathematics.

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