The preliminary research phases of learning devices based guided discovery development to improve the students’ problem solving ability of grade VII MTS/SMP

R P Hakim\textsuperscript{1} and A Asmar\textsuperscript{1}

\textsuperscript{1}Mathematics Department, Universitas Negeri Padang, Padang, Indonesia

*Corresponding author: riyhan.namikaze@gmail.com

Abstract. This research aims to develop a learning devices based on guided discovery methods that have valid, practical, and effective characteristics in order to improve the problem solving ability of grade VII SMP/MTs. The learning devices developed include lesson plan and student worksheet. The subject of this research was students of grade VII MTsN 1 Kerinci. The type of this research is development research using a PLOMP model that has three phases, namely, preliminary research, development or prototyping and assessment. The preliminary phase of research consists of needs analysis, curriculum analysis, student analysis, and concept analysis. Based on the results of preliminary research obtained the information that student problem-solving ability are not optimal, one of the factors that cause this is the unavailability of learning devices that can facilitate Students to improve their problem solving abilities. In the development or prototyping phase of the activities conducted is designing products such as lesson plan and student based Discovery guided, which then conducted a formative evaluation to determine the validity and practicality of the product. At the last stage, the assessment phase is conducted assessment of practicality test and effectiveness test.

1. Introduction
Mathematics is one of the most integral of the world of education. In this case, mathematics plays an important role in giving birth the generations who are competent and able to compete. To master the development of science and technology, it is necessary to understand mathematics as its foundation. This is in accordance with the two main visions of mathematics learning; (1) Directing mathematical Learning for the understanding of concepts that are then required to solve problems and other sciences, and (2) directing to a wider future i.e. mathematics provides solving ability, systematic, critical, thorough, objective and open. Such abilities are needed in facing of a constantly changing future [1].

Thus the importance of mathematics in human life in this century, but special in Indonesia is still very far from expected because it can be seen from the value of Indonesian students are still relatively low. The survey result of Programme of International student Assessment (PISA) in 2015 was released on December 06, 2016 showing that the Indonesian students Performa is still low on average scorers for science, reading, and mathematics were ranked at 62, 61, and 63 of the 69 countries that were evaluated. The rank and average of the Indonesian score was not absolutely different with the test and survey result of PISA in the year 2012, which is also in a low-material mastery group.

Survey of TIMSS (Trends in International Mathematics and Science Study) in 2015 also put Indonesia in low position at rank of 45 from 50 countries in mathematics. In general, Indonesian
students are weak in all content and cognitive aspect, both mathematical and scientific. But in deep diagnose found that the things that have been mastered and the things that need to be more attention. Indonesian students have a problem with the routine, the simple computation, and measures the knowledge of the facts that conjugated daily. But the Indonesian students need to be the ability to integrate the information, to get the conclusion, and to generalize the knowledge that they had to other things.

The 2 of results of this survey can be used as a benchmark for the achievement of mathematics education in Indonesia in global competition. Indonesia is a very concern for the development and quality of education in the future. Low achievement of Indonesian students in that program is much related to the learning of mathematics at school.

Learning mathematics at school has not fully familiarized the students to solve the questions that are included in the criteria of the PISA problem which presents a lot of mathematical skills. It is justified by research that says that the mathematical learning held in schools today still has not led to the improvement and development of students’ high-level mathematical thinking skills, one of them are Problem solving capabilities [2].

Mathematics learning in schools also tends to be one-way. Generally, the pattern of learning in schools consists of teachers explaining the subject, providing examples, providing training and ending learning by giving home tasks. By this way, the students tend to be passive and the only teachers who dominate in the classroom [3]. Teachers should be able to design meaningful learning contained the processes that make students to be more active so that the students are fully engaged in the learning process [4]. Direct involvement from students is expected to improve their mindset and students can have systematic thoughts on solving math problems [5]. Because at an ideal level, the learning process must ensure that students gain a learning experience that can be used to build their own knowledge [6]. This can be done if the teacher designs interesting learning activities and encourages students to find concepts and solve problems. To support such learning activities, teachers can use learning media or devices [7]. Learning devices can effectively help students in math learning to make learning to be more meaningful so that students can understand the material well[8]. So students not only copy what the teacher is showing, but they can also use their own understanding in learning[9].

The purpose of mathematics learning as stated in the regulation of the Minister of Education and Culture of the Republic of Indonesia No. 58 year 2014 said that one of the mathematical abilities to be mastered by students is the ability to solve Problem. Problem solving is an integral part of mathematics learning so that it cannot be separated from mathematics [10]. The problem solving is essentially the ability that a person has to solve the problem that it faces until the problem is no longer a problem for him[11]. Teaching students problem-solving, allowing the student to become more analytical in making decisions in his/her life[12]. This means that when students get familiar with the concept of resolving problems, the student will be able or able to make their own decisions, cause the students already have a ability on how to collect the information Useful, relevant, analyzing existing information, and to understand how important to do the research toward results that have been acquired. This problem solving capability aims to improve the analytical thinking of students in taking Decisions that help to make the perception of students in terms of viewing mathematics as an integral part of life.

In Indonesia, the students’ problem solving ability was still low, OecD (Organization for economic Cooperation and Development) in 2013 reported that Indonesian students was most weak in processing of formulating problems with a value of 368 (Himmah , 2016). Added Mairing (2017), which examined the ability of problem solving at 124 participants in Indonesia. The result showed that the 43% of students got low score, 51% was currently, and 6% is high one. Thus, it could be concluded that 94% of students had bad problem solving ability.

There are some things that are thought to be the cause of low of students mathematical problem solving abilities including: a learning process that is not maximized in improving student problem solving abilities, students do not used to accomplish the problem solving test and students have not been facilitated to perform activities that can improve their problem solving abilities[13].
One of way that can be used to help students to build their mathematical abilities is to provide learning devices that contain students’ learning activities [14]. One such learning device is students worksheet (LKPD). Student worksheet are one of the means to assist and facilitate the teaching and learning activities so that it will form effective interaction between students and educators, so as to improve the activity of students in improving learning achievements. But unfortunately the students worksheet (LKPD) used at school is not the result of the teacher's own development. The students still used the worksheet (LKPD) purchased on the market. It is very influential because not all content in the students’ worksheet (LKPD) according to the characteristics of students [15]. This shows the learning of mathematics in grade has not been maximized. Teachers tend to develop learning tools regardless of student learning style, this makes learning less than optimal [16]. The use of students worksheet (LKPD) should be tailored to the needs of the students so as to increase the understanding of students in the process of mastering the concepts and principles of mathematics as well as improving learning understanding of students [17].

Based on the analysis of the students worksheet (LKPD) used at the school cannot fully lead the students to be able to construct their own knowledge, this can be seen on the presentation of the material is still in direct provision at the core of the material By giving the final formula to be memorized by students. There are no activity steps that actively involve students. Then seen from the problem given to students are usually problems that are routine, so that students have difficulty resolving various questions. Such learning makes students less active and independent. In addition, for more effective learning, it also used lesson plan (RPP). RPP contains the learning steps that have to be implemented by teachers and students. RPP is used as a guide by teachers so that teacher and student learning activities are more directed to the classroom and learning activities will be well planned. But the analysis of the RPP used has not described the steps of activities performed by teachers and students in detail. The steps of the activity also have not provided sufficient opportunities for students to be actively involved in learning. Teachers should be able to choose and apply the right way to make sure students can learn well. As in terms of determining strategies, models and approaches in learning so that learning is more meaningful, easy to understand and useful for students for the future[18].

Based on the problem above, it is necessary to develop a learning devices based on guided discovery. Guided discovery is a learning model that can help students to construct their own knowledge through a series of learning activities, where teachers serve as facilitators who provide Referral assistance [15]. Is an alternative that is expected to activate the students,. The advantages of this guided discovery method can encourage active students in their learning activities because they think and uses their own abilities to find the final result. A guided discovery-based learning devices can improve students’ problem-solving abilities because students are faced with situations where students must be able to learn to be active, process-oriented, self-directing and seek themselves so that students can understand, plan, investigate and draw conclusions. New knowledge will be inherent for longer when the students are involved directly in the process of understanding and self-construct the concept or knowledge, so the learning can to be more meaningful.

The formulation of problem in this research is how the characteristics of mathematic learning devices based on valid, practical and effective guided discovery method that is developed and the impact of learning devices based guided discovery toward the students’ problem-solving abilities at seventh grade. The purpose of this research is to produce a method of finding valid, practical, and Effective methods of discovery for the effectiveness of Students in class VII. In addition, this research is expected to be beneficial for teachers and students in addition to learning devices that can be used in mathematics learning in schools. The results of this research in the form of lesson plan are designed to follow the learning methods based on discovery method and student worksheet which are designed in accordance with the principles and characteristics of a guided discovery method approach.
2. Methods
The type of this research is research and development. The products developed in this research are Lesson plan and student Worksheets which are based on discovery for students of the VII MTs class. In this research, the research model used was an adaptation of the model developed by Tjeerd Plomp which was declared as Plomp Research Model. The Plomp Model consists of three phases[19]:

1. The preliminary research is the preparation phases includes need, students, curriculum, and concept analysis.
2. Development or prototyping phase is the process of designing and developing student worksheet step by step through formative evaluation to evaluate and revise the prototype developed.
3. Assessment phase in the form of semi-summative evaluation to test whether the final prototype or the resulting product is in accordance with the desired quality, especially the criteria of practicality and effectiveness.

The implementation of the learning device test was conducted in students of grade VII of MTsN 1 Kerinci. Instruments used in this research include a list of interview questions, List of checklists, validation sheets, observation sheets, questionnaire and test questions. But before we use it, each of these instruments is validated by experts. Instruments that have fulfilled valid standards used in the research.

The data of research results are analyzed according to data type. Qualitative data is analyzed in a qualitative way and quantitative data is analyzed and categorized so that it can be taken into a qualitative conclusion.

3. Result and discussion
The following results are outlined based on the previews research and its implementation process. Preliminary analysis is done toward students of grade VIII of MTsN 1 Kerinci and SMP Negeri 26 Kerinci. The results of preliminary analysis are divided into needs analysis results, students’ analysis results, curriculum analysis, and concept analysis.

3.1. Needs analysis Results
The collection of information in this analysis is conducted by interviewing several teachers of MTsN 1 Kerinci and SMP Negeri 26 Kerinci related the problems in teaching and learning process and available learning devices. The information that the researcher found from interview some of teacher are about general problem found in process of teaching and learning, the common learning model, learning sources, and also expected learning sources.

Based on the results of interview with some teachers, the researcher found that there are teachers that didn’t use student worksheet, they only use textbook to convey the material to the students. While the teachers who Use the student worksheet said the student worksheet that is used by the the students is not optimally helps the students in comprehending the learning material. It is caused in the student worksheet, there is not the step by step of activities that can help the students in catching their own knowledge. It is identifies the students’ needs in form of new learning method beside the conventional one that can optimally the students’ problem solving abilities in mathematic.

In addition, researchers also observed the implementation of learning to see the teachers’ use of learning devices and to see the activities of the students. Based on the observation that is performed at the same time that the learning process is optimal. The teacher is a very domination in the class. The students is still have difficulties in asking what they want to ask to answer their teacher’s questions.

One of the solution that the researchers offered for the completion of the problem with the student worksheet, which is a device that helps you to help you to learn the desired learning. The student worksheet should be guided by the approach of learning that is directing the center, and based on the activities that could develop the ability to solve the problem of students. One of the learning method that could facilitate the ability to develop problem-solving skills is a guided Discovery.
Through student worksheet Based on the Discovery of guided, the participants improve their problem solving abilities, the invention is one of the models/Strategies who could be used to guide the ability to increase the Ability to solve the problem. The developed student worksheets should have use among others, the color, paper, illustrations, letters, etc. Because based on interviews done with some students it can be concluded that learners want a compelling teaching material, meaning that the provided student worksheet has something interesting, and not boring.

3.2. The students’ analysis results

Student analysis is performed to determine the characteristics of students through interviews with students and questionnaire. The characteristics of the learners that are seen include: academic ability, age, learning style, progression of thinking skills and motivation to learn, especially mathematics. So that the learning device is produced according to the characteristics of students. In this research, the students who are made the subject are seventh grade students of MTs.

Based on the student's analysis, the students can have a high, low and medium level of academic education. seventh grade students of MTs are in the age of Labil. Most of them just love to learn with the lessons they love. While the mathematics lesson is a lesson that is mostly less desirable by learners.

In the learning process, the teacher is not yet seen involving students actively. It can be seen from the less concentration of students even not focusing on the learning process delivered by teachers and some students instead performing Activities that not included in the learning activities. Information obtained from students about the use of student worksheet, is found that the student worksheet has not helped students to understand the material optimally. The material in the student worksheets presented directly and continued with the task. Also added by the students that student worksheet look is not yet interesting so it needs to be given variations to be more interesting. The students want an interesting and colourful student worksheet.

Based on the findings above, researchers feel the need to develop student worksheet based discovery that can accommodate the characters that students have in a positive direction in the learning process. Learning by using student worksheet based on discovery is guided to include steps that can guide learners to active from the beginning of the learning process.

3.3. Curriculum Analysis Results

In the course of curriculum analysis is conducted on curriculum 2013 for mathematics of seventh grade of MTs. Analyzing the curriculum aims to find out whether the material being taught already appropriate with the expected competencies. Curriculum analysis is focused on the analysis of KI and KD. Curriculum analysis aims to provide guidance in the development of a guided discovery based mathematics learning tool for seventh grade students of MTs. The results of KI and KD analysis contained in the standard content are translated into indicators Learning achievement. This analysis is the determination of indicators of algebraic form of seventh grade of MTs on odd semester is developed learning devices.

3.4. Results of concept analysis

The concept analysis aims to identify, detail, and systematically compile the main materials that the students will learn. The material is structured systematically. The main concept is that all material contained in the subject matter is presented on a guided discovery based learning device. It main material is the form of algebra with the sub-material introducing the form of algebra, understanding the addition and reduction of algebraic form, multiplication of algebraic form, division of algebraic form and understand how to solve the form of algebraic.
4. Conclusion
This development research produced the learning devices in form of lesson plan and student worksheet-based guided discovery to enhance the ability to solve the math problems of seventh grade, which is valid, practical and effective.

The pipeline of this learning devices development is done by using a three-phase Plomp development model that is the initial investigation phase, development phase and assessment phase. For the initial investigation phase/introduction carried out needs analysis, concept analysis, student analysis and curriculum analysis.

The result of needs analysis which was done in form of a characteristic of learning devices that the students wants based on discovery in form of lesson plan and student worksheet. The results of the curriculum analysis are basic competencies, core competencies, methods, teaching materials and learning strategies that will be used in learning the algebraic materials and process standards in accordance with the 2013 curriculum. The outcome of the students' analysis is the characteristic of learning devices suited to the characteristics of students to then develop a map of teaching materials concepts to be developed. While the result of the analysis of the concept of learning material is needed in the development so that the competency achievement indicator can be achieved.

Based on the results of the analyses at the preliminary investigation phase, the researchers concluded that it is crucial that a learning devices based guided discovery to be guided in improving problem solving abilities.

Because of the limitations of this research and remember of the importance of the development of these devices, the researchers suggest to other teachers and researchers to be able to develop a learning devices based guided discovery on the other material or class.

References
[1] Meltzer D 1967 Psycho-Analysis As a Human Activity Psycho-Analytical Process 92–95
[2] Annajami A 2016 Peningkatan Kemampuan Pemahaman Konsep Matematik Siswa SMP Melalui Metode Penemuan Terbimbing Berbantuan Software Geogebra, MES J. Math. Educ. Sci. no. ISSN : 2528-4363
[3] Rahmi I and Arnawa IM 2018 Developing learning instrument based on guided inquiry using eRA sequence to improve students’ problem solving skill Proc. Int. Conf. on Mathematics and Mathematics Education (ICM2E) 285 219–221
[4] Nurjamilah N, Yerizon Y and Permana D 2019 The influence of contextual teaching and learning model on students’ mathematical problem solving ability Proc. IcoIE 178 434–436
[5] Alindra D, Fauzan A and Asmar A 2019 Metacognitive awareness and its effect on students’ problem solving ability in implementing rme approach Proc. IcoIE 178 318–322.
[6] Eliza R, Fauzan A, Lufri L and Yerizon Y 2019 The validity of realistic problem based learning model development of mathematics learning in vocational high school (smk) Proc. IcoIE 178 12–18
[7] Roza N, Arnawa IM and Yerizon Y 2018 Practicality of mathematics learning tools based on discovery learning for topic sequence and series Int. J. Sci. Technol. Res. 7 236–241
[8] Asmar A, Sriningsih R and Arnellis A 2018 Needs analysis development of mathematics learning device based on 21st century skills in senior high school Proc. Int. Conf. on Mathematics and Mathematics Education (ICM2E) 285 34–38
[9] Nurvitasari S 2019 Pengaruh penerapan model discovery learning terhadap hasil belajar matematika peserta didik kelas vii smpn 13 padang 1114–1121
[10] Ersoy E 2016 Problem Solving and Its Teaching in Mathematics Online J. New Horizons Educ. 6 79–87
[11] “How To Solve It - George Polya.Pdf.”.
[12] Herman H 1988 Mengajar belajar matematika p. 2019
[13] Yulius B, Irwan I and Yerizon Y 2017 Pengembangan perangkat pembelajaran matematika berbasis model pembelajaran penemuan dengan masalah open ended untuk peserta didik sma
kelas X semester 2 *Mosharafa J. Pendidik. Mat.* 6 279–286

[14] Arnawa IM, Yerizon Y, Nita S and Putra RT 2019 Development of students’ worksheet based on apos theory approach to improve student achievement in learning system of linear equations *Int. J. Sci. Technol. Res.* 8 287–292

[15] Rahmi M, Yerizon Y and Musdi E 2018 Tahap preliminatory research pengembangan perangkat pembelajaran berbasis penemuan terbimbing untuk meningkatkan kemampuan komunikasi matematis peserta didik kelas viii mts/smp *Mosharafa J. Pendidik. Mat.* 6 237–246

[16] Yerizon Y, Putra AA and Subhan M 2018 Student responses toward student worksheets based on discovery learning for students with intrapersonal and interpersonal intelligence *IOP Conf. Ser. Mater. Sci. Eng.* 335

[17] Syafriafdi N, Fauzan A, Arnawa IM, Anwar S and Widada W 2019 The tools of mathematics learning based on realistic mathematics education approach in elementary school to improve math abilities *Univers. J. Educ. Res.* 7 1532–1536

[18] Asmar A and Oktavia B Learning tools based on connecting, organizing, reflecting and extending (core) models for class viii small classes valid *Proc. Int. Conf. on Mathematics and Mathematics Education (ICM2E)* 285 246–249

[19] Plomp T and Nieveen N 2007 An Introduction to Educational Design Research