

Development of Mathematics Learning Tools Based on Polya Model Problem Solving in Improving Students' Problem Solving Ability in Class VII MTS Negeri 3 Kerinci

Peri Agustian, I Made Arnawa

Abstract: The problem faced at school is not optimal ability of students' mathematical problem solving. That problem can be improved by using the Polya model problem solving based learning approach. The purpose of this study is to develop learning based on Polya's model problem solving to improve students' mathematical problem solving abilities. This type of research is development research using the Plomp model which consists of three phases, namely preliminary research, development phase or prototyping, and assessment phase. Questionnaires, teacher interview guidelines, field notes and preliminary tests were used as instruments. The results of data analysis show that 1) students' mathematical ability is low, 2) the learning process is focused on the teacher, 3) Lack of teaching materials that can be used by teachers to teach problem solving, 4) Students feel bored with too many problems and lack of interesting learning resources used. After the initial data was obtained, the researchers designed the product in the form of learning tools, namely RPP and LKPD, which passed the self-evaluation stage to see typos and punctuation errors, then the product was validated by 5 experts, and the product validity value given by the validator was 3,57 for RPP with very valid criteria and 3.19 for LKPD with valid criteria. A valid product is a one-to-one process to collect opinions and shortcomings of students who may still be in the LKPD which are then applied in small classes before being applied to large classes or one class

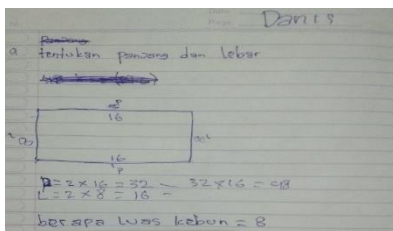
Index Terms - Learning tools (Worksheet (LKPD) and Lesson Plan (RPP)), Polya Problem Solving, Mathematical Problem Solving.

1. INTRODUCTION

Mathematics as a science has an important role not only in the development of human civilization, but also in everyday human social life. Therefore, mathematics is studied from elementary school to university. The purpose of mathematics learning is to practice the ability of high-level thinking to learners, namely one of them problem solving skills. But in fact the problem solving ability of students is known to be still low [1], [2], [3], [4], [5], [6]. This problem can also be seen from the preliminary research conducted by researchers at MTSN 13 Kerinci by giving problem solving questions and from the answers given by students as follows:

From the answers given by students, it appears that students do not identify the problem before starting to solve the problem and immediately answer by making a rectangular image and giving the value of the length and width. Difficulties are only seen when students want to determine the length, width and area of Mr. Robin's garden, because students do not understand the questions well and the unstructured completion steps. The results obtained by students as shown in table 1.

Robin's garden is rectangular in shape, if it is known that the surroundings of Mr. Robin's garden are 48 m and the length of the garden is twice its width. What is the actual length and width of Mr. Robin Garden? And what is the area of Mr. Robin's garden?



Picture 1. Student answer

Table 1

Percentage Problem Solving Ability test results for Class VII MTS Negeri 3 Kerinci

Class	Indicator	Percentage of Student Answers Per Score			
		0	1	2	3
VII A	Understand the problem	53,3%	33,3%	13,3%	-
VII B		63,6%	27,2%	18,1%	-
VII A	Devising a plan	60%	33,3%	6,6%	-
VII B		36,3%	54,5%	9,1%	-
VII A	carry out the plan	26,7%	20%	40%	13,3%
VII B		27,2%	45,4%	18,1%	9,1%
VII A	Looking back	66,7%	20%	13,3%	-
VII B		72,7%	18,1%	9,1%	-
Average score		50,4%	31,4%	15,9%	11,2%

- Lecturer of FMIPA, Andalas University arnawa1963@gmail.com
- Peri Agustian is graduate students from Universitas Negeri Padang, Indonesia periagustian888@gmail.com

From table 1 it can be seen that students' problem solving abilities need to be improved. However, to improve students' mathematical problem solving abilities is not easy. Learning that must be done to students is a problem faced by a teacher [7], therefore it requires the use of good strategies, where with that strategy more or less will have a positive impact on students, especially students who are of moderate and low ability with provide active and participatory responses and corrective feedback during the learning process in class [8].

From the results of researchers' interviews with subject teachers, it was found that the lack of students' interest in learning, teachers find it difficult to motivate students to be more active in learning, most students are ignorant even not paying attention to the teacher when explaining. And the methods that are often used by teachers are lecture, discussion and question and answer methods which cause less optimal problem solving abilities.

For teachers they the lack of teaching materials is an obstacle faced in explaining story questions to students. The LKPD used by the teacher so far has only assisted the teacher in explaining subject matter, especially materials that are routine with a series of formulas and examples of questions and exercises using the formulas that have been given. Meanwhile, to solve the problem in the form of a teacher's story is still very lacking.

The lack of optimal preparation of learning tools (RPP and LKPD) is one of the causes of ineffective learning. It is necessary to find a solution so that students' problem solving abilities can be overcome [9],[10].

One solution to improve students' mathematical problem solving skills is to develop a problem solving tool based on the Polya model. The problem solving provided by Polya becomes an alternative that can be used to help teachers and students improve problem solving. For Polya there are 4 steps in solving problems, starting from understanding the problem by writing down what is known and what is asked in the question, followed by making a plan for solving what is already known, only after that solve it based on the existing plan. Before completing the existing answers, it is corrected again if there are steps that were missed or incorrect operations.

The problem solving steps proposed by Polya provide the opportunity for students to be active in the teaching and learning process, develop abilities and involve skills in analyzing situations, can distinguish between facts and opinions, and objectives when making decisions [11]. The task of educators is as a facilitator and guide for students.

Problem solving Polya Model has several advantages, namely constructive students' mindset by analyzing before completion, integrating concepts and knowledge that have been learned and can organize problems by creating a framework when working on story problems, so that by applying the Polya model problem solving can help students in problem solving [12],[13].

The steps to solve the Polya model used in this study are the students' orientation to the problem (understanding the problem, planning a solution, carrying out the settlement and checking again), guiding students individually or in groups, presenting the results of group discussions, evaluating the results of the quiz and giving appreciation.

2. METHOD

The research conducted is development research, which is developing products based on needs that have been analyzed through preliminary analysis to help teachers and students in solving problems. The aim of this research is to produce a valid, practical and effective product in enhancing the problem solving ability of students in class VII MTSN 3 Kerinci.

The Plomp development model will be used as a foundation for development to be carried out. product development begins with preliminary research, after the initial investigation data is obtained then the product is made based on the results obtained for evaluation by the researchers themselves, experts, one-on-one with students, small groups and field tests, this stage is called the development stage, the last step What is done is the assessment stage, which is giving questions to be done by students to see the effectiveness of the products and questionnaires for teachers and students to see practicality.

3. RESULTS AND DISCUSSION

There is several analysis activities in the preliminary research phase (preliminary research) aimed to find out the problems contained in the learning process and know the things needed for learning tools that will be developed in Class VII MTSN 3 Kerinci students. The initial investigation phase consisted of four activities, namely:

a. Analysis needs

At the stage of needs analysis conducted interviews and observations of teaching and learning activities in the classroom. From interviews conducted with subject teachers it was found that teachers had difficulty in explaining and teaching questions in the form of stories to students, so students had low problem-solving abilities, especially in solving questions in the form of stories.

From observations made, it appears that there is a lack of interaction between the teacher and students because students prefer to ask their friends rather than the teacher. The learning process is still focused on the teacher, the students working on the sample questions on the board are the same students, if appointed by other students the students are not confident and shy.

One factor that causes teachers difficulty in explaining story problems is the lack of teaching materials such as worksheets that discuss about story problems. In the worksheets that are used to discuss more questions that are routine in which students can directly answer these questions using the formula that was taught before. In the form of a story, students can not directly answer the questions given before reading and understanding what information is important to know that will help students in answering questions and what the question wants to be solved.

b. Student Analysis

To obtain data about what becomes difficult for students, what is liked and not liked is done by giving a questionnaire. The questionnaire distributed to 26 students on the learning tools to be developed, obtained results, namely: 17 students had difficulty in solving problem stories, 5 students had difficulty using mathematical concepts. And 3 students had difficulty in using mathematical operations.

From the questions that students liked about LKPD, it was found that 13 students did not like too many questions, 3 students liked interesting pictures and 10 students liked colored LKPD. While the colors preferred by students found that 14 students liked the blue color, 5 students liked the green color, 4 students liked the red color and 3 students liked the yellow color.

c. Curriculum Analysis

Curriculum analysis is carried out on Algebraic Form material. At this stage, there is no change in the Basic Competence and only a few changes to the Achievement Indicators used by schools that are initially familiar with algebraic forms and identifying elements of algebraic forms are 2 separate indicators changed into one indicator taught at a meeting that is recognizing and identifying algebraic elements.

d. Concept Analysis

After analyzing the concepts based on 2013 curriculum VII class material odd semester consisting of integers, sets, algebraic forms and linear equations of one variable. The material in the form of algebra was chosen as the material of the developed learning tool. Based on the analysis of the concept carried out, the learning material recognizes and identifies the elements in algebra taught first, this is because students will get to know about how the form of algebra and the elements in the form of algebra. After the students know the form and elements of algebra, then the students can operate on the algebraic form, namely addition, subtraction, multiplication, division, addition and subtraction of fractions, and multiplication and division of fractions in algebraic form.

The problem given is a real problem or daily events that are close to students that are presented in the form of stories so that they can help develop students' mathematical knowledge [14].

After obtaining preliminary data about students' needs, product development will be implemented in class in the form of lesson plans and workshops based on problem solving in the Poya model. The RPP and LKPD are made based on the needs of students who were first examined by researchers to see whether there were typos and punctuation in the RPP and LKPD. The next stage of development carried out is as follows::

a. RPP validation

RPP validation is carried out by 5 validators. The aspects assessed in the lesson plan are aspects of the components and indicators of achievement indicators of competence, learning objectives, teaching materials, approaches, models and learning methods, learning steps, learning resources and learning tools, assessment, language and writing.

Based on the validator's suggestions, a revised RPP is carried out to obtain a valid RPP. Some of the suggestions given by the validator are to pay attention to the space or distance between paragraphs and between tables and paragraphs, inserting student and teacher activities into the lesson plan what are the activities of students and teachers in the learning based problem solving Polya model and points on the lesson plan should in order.

After making improvements based on suggestions and input from the validator, then the validator provides an

assessment of the RPP that was designed. The results of the RPP validation based on the problem solving of the polya model on all aspects can be seen in Table 2.

Table 2. RPP Validation results

No	Validation Aspects	Validity Index	Category
1.	RPP Component	3,56	Very Valid
2	Language	3,62	Very Valid
Average Validity Index		3,57	Very Valid

The results of the validator obtained an average index of the validity of the RPP based Polya model problem solving is 3.57. So, it can be concluded that the RPP based on solving the Polya model is valid.

b. LKPD Validation

LKPD validation was also carried out by 5 validators namely 3 mathematic education experts to assess the contents of the product, 1 Indonesian language expert to assess the terms of language and 1 educational technology expert to validate the display aspect.

Some suggestions given by the validator to be corrected are mistakes in the use of letters in the word Junior / Mts where words Mts and Junior High should be written in all capital letters to SMP / MTS, activities in LKPD that are reversed are to pray first then read bismillah then the validator suggests a sequence the truth is to read bismillah first and then pray, and correct the sentence in the problem.

After we are making improvements based on suggestions and input from the validator, then the validator provides an assessment of the designed LKPD. The results of the validation of LKPD based on problem solving in the polya model on all aspects can be seen in Table 3.

Table 3. LKPD Validation Results

No	Validation Aspects	Validity Index	Category
1.	Presentation and Content	3,58	Very Valid
2.	language	3	Valid
3.	Display	3	Valid
Average Validity Index		3,19	Valid

The results of the validator obtained an average index of the validity of the RPP based Polya model problem solving was 3.19. So, it can be concluded that the RPP based on solving the Polya model is valid.

c. One to one evaluation

LKPD which has been validated and revised, is then conducted a one-to-one test with the aim of asking for input on the products developed by students. This individual

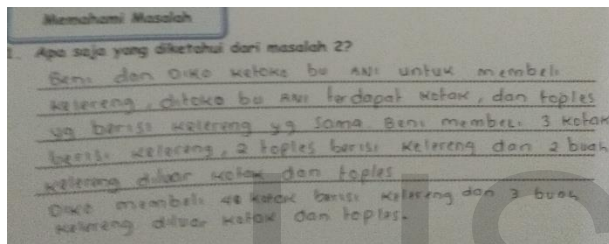
evaluation was carried out by asking 3 students from class VII C of MTS Negeri 3 Kerinci who had different abilities, namely one person with high ability, one person with moderate ability and one person with low ability.

The researcher cooperates with the Mathematics subject teacher are asking the willingness of the students to carry out the trial on a predetermined schedule, then ask students for opinions after using LKPD.

LKPD is given to 3 students the same at each meeting, and students are asked to try to work LKPD based on the instructions available in LKPD. This individual evaluation was carried out on the six LKPD.

1) LKPD 1

Interesting events that occurred during the process of one to one evaluation at the first meeting the use of LKPD in the classroom that students are confused in determining what should be written in the column known and asked, which finally students write the whole story in the LKPD into the answer column. As shown in the following image..



Picture 2. Student Answer

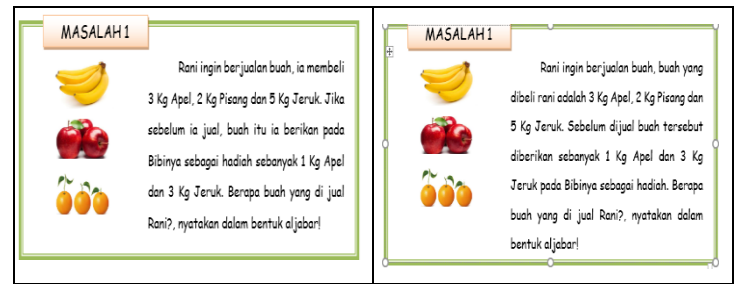
.At this first meeting through observation and discussion of researchers and students that need to be improved is to simplify the instructions for use with a shorter language in order to facilitate students in understanding what needs to be done during the use of LKPD and improve punctuation in problem 2 using question marks with commas.

2) LKPD 2

The next meeting, namely at the second meeting, nothing special happened. In using LKPD students only still lack confidence in what they are doing so many ask the teacher. And at the second meeting the researchers only simplified sentences and did not repeat too many sentences while the revision results can be seen in the following table.

Table 4. Revision to LKPD 2

Before	After
--------	-------



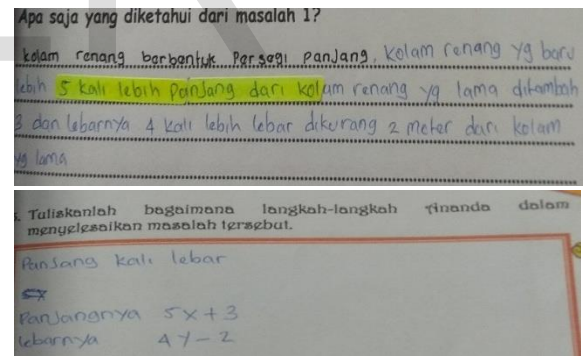
3) LKPD 3

The material in LKPD 3 is about the multiplication of algebraic forms, in this material students already know what to do in the step of understanding the problem by writing down what is known and what is asked, but students have difficulty in changing what is known from the information on LKPD into the form the algebra.

At this third meeting the researchers did not make any improvement, according to the researchers the questions given had helped the students to jointly solve the problem and match the steps used in this study, the polya model, and the researchers assessed that the questions in the LKPD were not too long..

4) LKPD 4

In LKPD 4, students have no problem in writing information from the problems given and have started to think about themselves and try to answer the questions themselves in LKPD as shown in the answers of students below.



Picture 3. Student Answer

In LKPD 4 the researcher also did not make improvements because there was no input from students and the researchers considered LKPD 4 to be good, both in writing and in the matter in LKPD. The difficulty experienced by students is the ability of students to carry out the distribution operation itself.

5) LKPD 5

In LKPD 5, understanding the problem and planning the problem is not a difficult problem for students but the problem-solving ability of the indicators of solving students' problems takes a long time because the students have not yet fully understood the operations on the addition and subtraction of fraction algebraic forms. The improvement made at LKPD 5 is based on

input from students is that there is a slight typing error in the practice questions, namely the existence of 2 words together.

6) LKPD 6

In this LKPD 6 activity the ability of students to understand problems, plan solutions, carry out resolutions and check back is better than previous meetings. Although in its completion the students still need guidance from the teacher, overall the activities in LKPD have been understood and can be carried out by the three students.

d. Small group

Small group evaluations are carried out by practicing learning tools that have been designed for 6 different students from one to one evaluation. 6 students consisted of 2 people with high ability, 2 people with medium ability and 2 people with low ability. Small group evaluations are conducted during 6 meetings on algebraic material. The following activities are carried out during the Small Group Evaluation process::

1) LKPD 1

Before giving LKPD to students, the teacher first explains the material in front of the class about recognizing algebraic forms and elements in algebra after that, and then the teacher divides the groups and divides LKPD to each group and starts discussing to solve problems 1 and 2 to LKPD.

At the first meeting students are confused about what information will be written because students are rarely taught or given questions in the form of stories before, but by asking students to read the problems given and guidance from the teacher, students gradually begin to be able to write them down.

After writing down information and questions on the problems contained in LKPD 1, students with the guidance of the teacher plan a solution with group members, each group discussing the steps used to solve the problem. Because students are in groups, students can solve problems faster than students in one to one.

After each group has finished working on it, one of the students comes forward to present the results of their group discussion together between the teacher and the student to double check whether there are steps that were missed during the problem solving process. The process that occurs as shown in the following image:



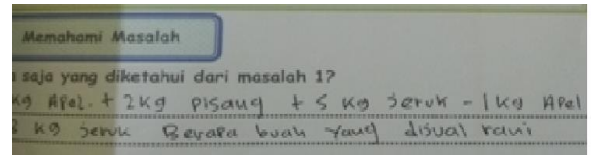
Picture 4. Student activities in small groups

2) LKPD 2

In this second meeting the ability of students to understand the problem began to improve from the first meeting, this was seen when LKPD was distributed students no longer need to ask the teacher what to write that was known from the questions and what was

asked, although there were still 1.2 people students who look still do not understand.

From the students' answers, there are students who may be due to not focusing or not paying attention and reading the steps in the LKPD well, there are students who write known and asked in one place, whereas the place to write is known in LKPD and asked separate. As seen from the following student answers.



Picture 4. Student Answer

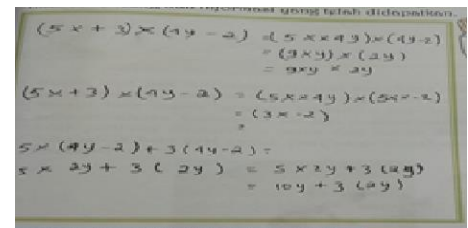
Anticipating the problem so that it does not happen again when carrying out the field test, the researcher combines the known and the asked into one answer column, as shown in table 5.

Table 5. Small Group Revision

Before	After
<p>1. Apa saja yang diketahui dari masalah 1?</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>diberikan sebanyak 1 Kg Apel dan 3 Kg Jeruk pada Bibinya sebagai hadiah. Berapa buah yang di jual Rawi?, nyatakan dalam bentuk aljabar!</p> <p>Mamahami Masalah</p> <p>1. Apa saja yang diketahui dan yang ditanyakan dari masalah 1?</p> <p>Diketahui :</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>Ditanyakan :</p> <p>.....</p> <p>.....</p> <p>.....</p>

3) LKPD 3

Students at this third meeting already understood the first step in solving the Polya model problem, namely understanding the problem. The difficulty experienced is changing the information obtained into algebraic form, after discussion and guidance given by the student teacher can change it into algebraic form and finish it. Although there are still students who are wrong when doing multiplication operations on the questions given. Like the students' answers below



Picture 4. Student Answer

4) LKPD 4

At the fourth meeting not too many difficulties experienced by students in working on problems in LKPD, the ability of students to understand the problem has begun to increase from the previous meeting,

students are also accustomed to planning ideas that are used to solve the problems given.

Difficulties experienced by students are to carry out operations on the division arranged in algebraic form. Most students in completing each step in LKPD ask more questions about how to re-check the answers in the last step because they do not understand the meaning of the sentence in that step.

5) LKPD 5

At LKPD 5 Students already understand what they have to do in each step in the given LKPD and can answer fairly well with the guidance of the teacher but just like at the 4th meeting students still ask about the last step that they don't understand and don't know what which must be done. the last step in LKPD is most often asked by students during the learning process, not only LKPD 4 but also frequently asked in LKPD 1 and 2.

Because many students ask questions, this indicates that students do not understand what they want in the sentence contained in the final step of the LKPD. Therefore the researcher refines the sentence so that it is easier to understand and more operational. Improvements made as shown in table 5.

Table 5. Small Group revision

Before
<p>Ayo periksa kembali hasil yang diperoleh</p> <p>5. Cocokkanlah kembali penyelesaian yang Ananda dapatkan dengan masalah yang diberikan, apakah langkah-langkah penyelesaiannya sudah benar?</p> <p>.....</p>
After
<p>Ayo periksa kembali hasil yang diperoleh</p> <p>4. Periksalah kembali jawaban ananda, apakah langkah-langkah dan operasi yang digunakan sudah benar?</p>

6) LKPD 6

At LKPD 6 students are familiar with the given LKPD and already understand what steps they have to take during the use of LKPD. And with the guidance of the teacher students can complete all steps well. There were no improvements made in LKPD 6 because the researchers considered that the questions in LKPD were already good and there was no input from students for improvements to LKPD. The difficulty experienced is the difficulty in operating the mathematical concepts that are not related to the developed LKPD.

After all meetings are held, students are asked to fill in the questionnaire of students' responses to the LKPD based on the Polya model problem solving that has been used. The results of the student questionnaire analysis can be seen in the following table.

Table 6. Practical Questionnaire results

No	Rated aspect	Practical Value	Criteria
1	instruction	87,5	Very Practical
2	time	83,3	Practical
3	legibility	87,5	Very Practical
4	Convenience	79,8	Practical
5	Display	82,5	Practical

Based on the analysis of students' responses to the practicality of LKPD based on Polya's problem solving model, it is in the practical and very practical categories. This means that LKPD is practical for use in learning.

Mathematical problem-solving ability tests at this stage are also given to students. Broadly speaking, in this Small Group those who completed were 4 students and those who did not complete were 2 students with an average student test score of 70.6 and overall criteria based on the criteria set at 66%. then the learning tool can be said to have been effective.

4. CONCLUSION

From all the activities that have been carried out, it can be concluded that the learning tools based on problem solving in this polya model have passed each preliminary research step consisting of needs analysis, student analysis, curriculum analysis and concept analysis and development stage consisting of self-evaluation, one-to-one evaluation and small group needed to make a valid, practical and effective product.

5. ACKNOWLEDGMENT

Acknowledgement: We thank MTSN 3 Kerinci and Padang University, UNP for giving us the opportunity to conduct this research. We also thank Management and students from the School who participated in this study.

6. REFERENCES

- [1] Arnawa I M, Yerizon, Nita S and Putra R T. (2019). Int J.Sci. Tech Res. **8** .287-292.
- [2] Ifanali. (2014). Penerapan Langkah-Langkah Polya Untuk Meningkatkan Kemampuan Pemecahan Masalah Soal Cerita Pecahan Pada Peserta didik Kelas VII SMP Negeri 13 Palu. Jurnal Elektronik Pendidikan Matematika Tadulako, Vol 01. No 02.
- [3] Paranginangin, Surya. (2017). An Analysis of Students' Mathematics Problem Solving Ability in VII Grade at SMP Negeri 4 Pancurbatu. International Journal of Sciences: Basic and Applied Research (IJSBAR) (2017) Vol 33, No 2 p 57-67
- [4] Sumartini, T.S.(2016). Peningkatan Kemampuan Pemecahan Masalah Matematis Peserta didik melalui Pembelajaran Berbasis Masalah. Jurnal "Mosharafa".Vol 5. No2.
- [5] Thuy, Phi Van. (2017). Developing Students' Metacognitive Skills In Mathematics Classroom.

- Vietnam: Anale. Seria Informatică. Vol. XV fasc. 1 – 2017.
- [6] yuliasari, Nova. (2018). Eksperimentasi Model Pembelajaran Kooperatif Tipe Teams Game Tournament Terhadap Kemampuan Pemecahan Masalah Matematis Ditinjau Dari Kemampuan Awal. Mat-Edukasia. Vol. 3 No. 2.
- [7] Syarifuddin, H. (2018). The Effect of Using Concept Maps in Elementary Linear Algebra Course on Students' Learning. (Jurnal), (<https://www.researchgate.net>, 12 Februari 2019).
- [8] Arnawa, I Made. (2007). Mengembangkan Kualiatas Pemahaman Dalam Aljabar Abstrak Melalui Pembelajaran Berdasarkan Teori APOS. Jurnal Pendidikan dan Kebudayaan No.06
- [9] Barlenti, I. (2017). Pengembangan LKS Berbasis Project Based Learning untuk Meningkatkan Pemahaman Konsep. (Jurnal), (<http://www.jurnal.unsyiah.ac.id>, 12 Februari 2019).
- 1[0] Iqbal, M. (2017). Pengembangan lembar kerja peserta didik (LKPD) Dengan Pendekatan Kontekstual Ditinjau Dari Pemahaman Konsep Dan Disposisi Matematis. (Jurnal), (<http://digilib.unila.ac.id>, 13 Februari 2019).
- [11] Killen, Roy. (2007). Efective Teaching Strategy (4th Ed). Australia: Cengage.
- [12] Anwar . (2013). Penggunaan Langkah Pemecahan Masalah Polya Dalam Menyelesaikan Soal Cerita Pada Materi Perbandingan Di Kelas VI Mi Al-Ibrohimy Galis Bangkalan. Jurnal Pendidikan Matematika e-Pensa. Vol 01. No. 01.
- [13] Astuti, Sri. (2015). Pengembangan Perangkat Pembelajaran Berbasis Problem Solving Model Polya Dalam Peningkatan Keterampilan Berpikir Kritis Pokok Bahasan Barisan Bilangan Peserta didik Kelas IX SMP Negeri 3 Kota Probolinggo. Pancaran, Vol 4.p. 149-162.
- [14] Musdi, Edwin. (2016). Mathematics Instructional Model Based on Realistic Mathematics Education to Promote Problem Solving Ability at Junior High School Padang. AL-TA'LIM JOURNAL,23(1),p.65-77.