DEVELOPING THE LEARNING SET FOR THE TOPIC OF PYTHAGOREAN THEOREM USING PROBLEM SOLVING APPROACH REFERS TO THE LEARNING TRAJECTORY WITH PROBLEM SOLVING STUDENT'S ABILITY ORIENTATION

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Abstract

This study aims to produce learning set that includes Lesson Plan and Student Worksheet for the topic of Pythagorean theorem which are valid, practical and effective. Learning set that are developed using problem solving approach refers to the learning trajectory with problem solving ability oriented to junior high school students of class VIII. Type of the research was research and development with ADDIE model consisting of Analysis, Design, Development, Implementation, and Evaluation. This research paradigm is mixed method research by using embedded mixed method design. The instruments used in this research were validation sheets for measuring the validity of the learning set, student's and teacher's questionnaire for measuring the practicality, and test to measure the effectiveness of learning set. The results of this research are lesson plan and student worksheets using problem solving approach refers to the learning trajectory. Based on the results of validation assessment, the lesson plan was very valid with a score of 4,24 on a scale 5. While validation assessment of student worksheets obtained a score of 4,15 on a scale 5 with "valid" category. Based on practicality assessment results of student's questionnaire obtained a score of 3,01 on a scale 4 with "practical" category and teacher's questionnaire obtained a score of 3,45 on a scale 4 with "very practical" category. Effectiveness assesment using test obtained the level of completeness is 84.34%. Then, the average test score of the class obtained of 81.81 which indicates greater than minimum accomplishment criteria i.e. 75. So that, the learning set is effective.
Keyword: learning set, problem solving, learning trajectory

INTRODUCTION

Education is the most important component to determine the quality of a nation. Improving the quality of education has been done in various ways including reforming education by renewing the curriculum and reforming the teachers. Teachers as direct implementers of education and learning are very important to improve the quality of education (Jatirahayu, 2013 p. 53). Teachers are expected to teach using innovative methods in order to achieve the goals of national education. If you see the condition of the current education, teachers in Indonesia are not a bit who did the conventional teaching by lecturing or expository.

According to data from World Bank Study (2010), the percentage of expository learning practices by mathematics teachers in Indonesia is still quite large at 52%. Expository learning does not provide enough opportunity for students to develop interpersonal skills, thinking skills, skills to adapt to either. In expository learning, teachers dominate classroom activities and exercises that are routinely given and students are passive in learning process so that students's skill in problem solving is still lacking (Amir, 2010 p. 4). Problem solving as one of the purposes of mathematical subjects will difficult to achieve if the learning is still using expository.

Low ability students in solving mathematical problems is reflected by the results of TIMSS study. Since participating in TIMSS in 1999, Indonesia has not been a satisfactory achievements. In TIMSS 2003 study results demonstrate the achievements of students in TIMSS is ranked 35 of 48 countries with acquisition score of 397. In TIMSS 2007, Indonesia was ranked 34 out of the 45 countries with acquisition score of 411. In TIMSS 2011, Indonesia dropped in rank 41 of the 45 countries with an acquisition score of 386 (Setiadi, et al,

2012). Results of TIMMS 2003, 2007 and 2011 is still classified as low compared with an international average score of 500.

One of the causes of low student problem solving ability is the lack of use of exercises that problem solving skills oriented. Lack of the development facilities of problem solving skills are also a factor of low student problem solving ability because students unfamiliar with the problem solving exercises. Based on these descriptions, problem solving skills have not been developed to the maximum.

Problem solving is already prevalent in the sphere of education. Problem solving become one important part in learning of mathematics, because problem soving purposes covering the daily life. Problem solving is seen as a process used to resolve the problem (Widjajanti, 2009 p. 404). Polya in his book "How to Solve It" provides four steps in solving mathematical problems includes (1) understanding the problem, (2) devising a plan, (3) carrying out the plan and (4) looking back. Problem solving learning include a process to solve a problem that can help students to develop problem-solving abilities.

Reflectry upon the importance of problem solving, students are required to think critically, logically and creatively in solving problems given by the teacher. Students have good problem-solving abilities when students have been able to implement the steps in problem solving when faced the problem. Lestari (2015, p. 85) mentions some indicators which can measure the student's problem solving ability as follows: (1) write down the known elements and asked questions, as well as the adequacy of the required elements, (2) formulate a mathematical problems or devise a mathematical model, (3) implement a strategy to resolve the problem, (4) explain or interpret the results of problem resolution. Problem solving skills will help students in mastering the various subjects in school so that students won't feel difficulty in accepting questions on subjects that require problem-solving ability. Therefore, development of learning set which facilitate students in developing problem-solving ability are needed.

Learning set is one of the components that can be developed appropriate teacher curriculum development. Lesson Plan (RPP) and the Student worksheet (LKS) are a learning set components. A good LKS should pay attention to students' learning trajectories which have been studied by the students until they will learn at the next level. Hypothetical learning trajectory provides teachers for making a particular instructional design, so that teachers can predict how the learning might proceed(Simon, 1995 p.136). It can be shown by creating learning plan that comes with an explanation of the teaching in every situation as well as the decision of the spontaneous thoughts in response to student's thinking. Empirically, learning trajectory supported at the level of or way of thinking of students in using the knowledge which has been acquired (Daro, Mosher & Corcoran, 2011, p.12). In addition, the learning trajectory also includes hypotheses of student's thinking in understanding of mathematics, so that can be used by teachers in addressing the diverse student response. Therefore, the learning trajectory is not only used on student worksheet but is also used in lesson plan.

Hamzah (2014, p.56) stated that lesson plan (RPP) is a set of components that are in a learning system to guide the application of learning to achieve the learning objectives. Looking back on the importance of learning trajectory in learning, then the RPP as a guide the implementation of learning needs to be equipped with hypotheses way of thinking of students in learning and teacher support in responding to the possibility of student's thinking, so that learning objectives can be achieved as planned.

Clements and Sarama (the Consortium for Policy Research in Education, 2011) involves three main components on a learning trajectory that is (1) instructional experience and tasks that are suspected to cause mental processes of students, (2) students thinking with developmental level thinking of students, (3) the desired learning objectives. Based on the above description of the learning trajectory in mathematics, teachers should prepare a lesson plan that includes hypotheses student's thinking in learning something and the responses of teachers when facing variety of diverse levels of student thinking.

Of these problems, development of learning set such as lesson plan and student worksheet using problem solving approach refers to learning trajectory are needed. Developing learning set using problem solving

approach refers to learning trajectory are expected to facilitate students in developing problem-solving ability. Not only that, learning trajectory as the reference can support teaching and learning activities both for teachers and students in the classroom.

RESEARCH METHOD

Type of Research

The type of research was Research and Development. This study is focused on the development of learning set using problem solving approach refers to the learning trajectory with problem solving ability oriented and refers to the learning trajectory. Products that are developed namely Lesson Plan (RPP) and Student Worksheet (LKS). This research paradigm is mixed method research by using embedded mixed method design. Mixed methods involves combining or integration of qualitative and quantitative research and data in a research study (Creswell, 2014). In this research, researcher using embedded mixed method design where qualitative research is a big part of this research and quantitative data used as supporting data of research result.

Research Design

The development of this learning set using ADDIE development model developed by Dick and Carey. ADDIE model of development through 5 steps: Analysis, Design, Development, Implementation and Evaluation.

In the stage of analysis, there were three types of analysis that included analysis of the competence, analysis of the characteristics of the students, and instructional analysis (analysis of learning).

In the stage of design, researcher devised learning set design that consists of designing of lesson plans and student worksheet using problem solving approach and refers to the learning trajectory and designing of research instruments.

In the stage of development, researcher developed learning set consists of creating of RPP, creating of LKS, and creating of the research instruments. Then the product will be validated by expert lecturers and mathematics teacher then continued the revision phase of the product.

Stage of implementation was the trial of learning set in the classroom. This stage aims to know the practicality and effectiveness of learning sets are used.

The stage of evaluation included analysis of practicality and effectiveness after implementation of a learning set that are developed.

Object of Research

The object of research was Lesson Plan (RPP) and the student worksheet (LKS) of class VIII using problem solving approach refers to learning trajectory.

Location and Time Research

This study is undertaken in State Junior High School (SMPN) 1 Mlati at Sanggrahan, Tirtoadi, Mlati, Sleman, Yogyakarta. The study was carried out on 04 February 2017 until 04 March 2017.

Data Source

Data source derived from the eighth grade Junior High School students, experts lecturer and mathematics teacher. Junior High School students of class VIII is required to analyze the practicality and effectiveness of LKS that are developed. Expert lecturers are required to test the validity of the products developed, while the mathematics teacher is required to test the validity and practicality of the products developed.

Type of Data

The types of data in this study were qualitative and quantitative. Qualitative data obtained from feedback and suggestions from lecturers, teacher and students regarding learning sets that are developed. Quantitative data obtained from the scores of learning set validation assessment sheets, data of students's questionnaire and teacher's questionnaire and achievement of problem solving tests.

Instrument

Instruments used to measure the validity are RPP validation sheets and LKS validation sheets. Practicality is measured by using students's questionnaire and teacher's questionnaire. While the effectiveness is

measured by using problem solving test. Problem-solving test is one form of development of products in the form of problem-solving questions that measure the ability of the students after using LKS that are developed.

Data Analysis Techniques

The data analysis in this study aims to describe the validity, practicality and effectiveness of the learning set using problem solving approach refers to learning trajectory. Analysis of data validity is through calculating the average score then the average score is converted to a scale of 5. References of conversion score to a scale of 5 scale are based on Widoyoko (2009 p.238) that are presented in the following table.

Table 1. Conversion Score on a scale of 5

Formula	Category
$X > \bar{X}_i + 1{,}8 \times sb_i$	Very Good
$\bar{X}_i + 0{,}6 \times sb_i < X \leq \bar{X}_i + 1{,}8 \times sb_i$	Good
$\bar{X}_i - 0{,}6 \times sb_i < X \leq \bar{X}_i + 0{,}6 \times sb_i$	Fair
$\bar{X}_i - 1{,}8 \times sb_i < X \leq \bar{X}_i - 0{,}6 \times sb_i$	Poor
$X \leq \bar{X}_i - 1{,}8 \times sb_i$	Very Poor

Description:

$\bar{X}_i$ = ideal average
= $\frac{1}{2}$ (ideal maximum score + ideal minimum score)

sb_i = standar deviation
= $\frac{1}{6}$ (ideal maximum score - ideal minimum score)

X = average score obtained

Practicality analysis was done by analyzing the results of the students's questionnaire and teacher's questionnaire using a conversion scale of 4. The analysis was performed by calculating the average score then the average score is converted on the scale 4. Reference conversion scale 4 is obtained by calculating the interval from 1 to 4 that is equal to 0.75 as presented in the following table.

Table 2. Conversion Score on a scale of 4

Interval	Category
$3{,}25 < \bar{x} \leq 4{,}0$	Very Practical
$2{,}5 < \bar{x} \leq 3{,}25$	Practical
$1{,}75 < \bar{x} \leq 2{,}5$	Less Practical
$1{,}0 \leq \bar{x} \leq 1{,}75$	Very Less Practical

Description : $\bar{x}$ = average score obtained

Determination of criteria for the effectiveness of the learning set is by analyzing the results of problem solving tests. Each item contains aspects of problem-solving ability. Effectiveness analysis is done through the following steps: (1) determining the problem-solving test results of each student, (2) calculating the average score of the class, (3) determining completeness criteria of each student based on the standard Minimum Accomplishment Criteria or *Kriteria Ketuntasan Minimal* (KKM) applicable in school i.e. 75, (4)determine percentage of students who achieve completeness criteria.

At the stage of determining the average score of the the class, there is normality test to determine the data derived comes from a normal distributed population or not with the following hypotheses.

H_0: data derived from a normally distributed population.

H_1: data derived from a population that are not normally distributed.

Normality test using SPSS statistics with one-sample Kolmogorov-Smirnov test. Decision criteria acceptable if the significance value > α = 0.05.

In addition to the normality test, there was hypotheses test to determine whether the learning set can already be said to be effective if the average score of the class more than 75. This test using statistical test with one sample t-test.

Criteria for the determination of effectiveness of learning set is if the percentage of students who reach the KKM more than 75% and the average test score of the class more than KKM i.e. 75.

Thus, the overall criteria for the determination of validity, practicality and effectiveness of the learning set for the topic of Pythagorean theorem using problem solving approach refers to the learning trajectory with problem solving ability oriented satisfy the following indicators: (1) the result of assesment by the validators indicate the minimum assessment criteria for "valid", (2) the results of the assessment of students and teachers indicate the minimum criteria for "practical", (3) the percentage of students who reach the KKM is more than 75% and the average test score of the class reach more than KKM i.e. 75.

RESULT AND DISCUSSION

Description result of learning set development using ADDIE development model.

Stage of Analysis

On the competencies analysis obtained analyzing the basic competence or *Kompetensi Dasar* (KD) and developing of learning indicators referring to the curriculum 2013. Based on the analysis of the characteristics of students showed that students are active learners demonstrated by the many of questions from student and student's activity when answering the questions provided by the teacher. On the other hand, the problems that given by teacher are application of formula's problem, so that students easily to answer it. So when given a problem that practice the problem solving skills that does not directly apply the formula, the students have not been able to complete properly.

Eigth grade junior high school students are on formal operational stage means that students are able to create mathematical models and being able to write down the problems in the simple form by using symbols and notation. Students on a formal stage already has the capacity and use of abstract principles so that complex problem resolution can be given to the junior high school students of class VIII (Siswoyo, et al, 2013 p.101). In addition according instructional analysis, the role of teachers still dominates in the classroom and do not always notice the way of student's thinking. Teachers also use LKS provided by school without developing their own LKS.

Stage of Design

The main intention of this stage was developing the draft. In the next step, this draft was reviewed. Preparation of RPP was used to design a learning process in the classroom in order to make an effective teaching and reach the learning objectives. The process of preparation of the RPP also noted hypotheses of students thinking as one of the components of the learning trajectory. Hypotheses of students thinking written in the RPP are based on the results of the analysis of the characteristics of the students obtained from observations in the classroom. In line with Nurdin (2011, p.2), when designing lesson plan using learning trajectory need include hypotheses about how students learn and how students think. Not only writing the hypotheses of student reaction or possibility of the students answer, but also writing support/motivation from teachers when faced reactions of diverse students. Each LKS is given an issue that will be resolved through the activity of the students. LKS also provide steps in solving problems which include understanding the problem, devising a plan, carrying out the plan and looking back. One of the indicators of learning trajectory that included at LKS is the activities of students in finding a concept of Pythagoras.

Stage of Development

Product development process is made according to the design of lesson plan and student worksheet using problem solving approach refers to learning trajectory.

RPP validation results observed from 8 aspects referring to Regulation of the minister of education and culture or *Peraturan menteri pendidikan dan kebudayaan* No. 81 A in 2013, namely the identity of the school, the outline of learning objectives, subject matter, time allocation, learning methods, media and learning resources, learning activity and assessment techniques. The preparation of learning activity based on a problem-solving approach that includes activities to understand the problem, devise a plan, carry out the plan and look back. In addition, on the learning activities also provided hypotheses of student's answers as a result of the student's thinking and teachers support in the learning process when faced a situation which a variety of students. Inclusion of student's answers and support of teachers in the learning activities is one of the components of the learning trajectory that was developed from the learning set. Seven of the 8 aspects of the RPP validation assessment obtained the average score valid category, while the validator give value with very valid category on the identity of the school.

Table 3. Analysis of RPP Validation

No	Aspects of Assesment	Average Score	Category
1	School Identity	5	Very Valid
2	The Outline Of Learning Objectives	4,11	Valid
3	Subject	4,17	Valid
4	Time Allocation	4	Valid
5	Learning Method	4,17	Valid
6	Media dan Learning Resources	4,05	Valid
7	Learning	4,11	Valid

	Activity		
8	Assesment	4,09	Valid
Average Score		**4,24**	**Very Valid**

The results of the LKS validation assessment in terms of 5 aspects which refers to Darmodjo and R.E. Kaligis about requirements of LKS. The first aspect is conformity with the didactic requirements obtained an average score of 3.95 with a valid category. The second aspect is conformity with the construction requirements which obtained a score of 4.37 with very valid category. The third aspect and fourth aspect i.e. conformity with the material/content and conformity with LKS using problem solving approach refers to learning trajectory obtained an average score of 4.11 and 3.94 respectively with a valid category. The fifth aspect is conformity with the technical requirements obtained an average score of 4.31 with a very valid category.

Tabel 4. Analysis of LKS Validation Assesment

No.	Aspects of Assesment	Average Score	Category
1	The didactic requirements	3,95	Valid
2	The construction requirements	4,37	Very Valid
3	The material/content	4,11	Valid
4	Problem solving approach on the basis of learning trajectory	3,94	Valid
5	The technical requirements	4,31	Very Valid
Average Score		**4,15**	**Valid**

Stages of Implementation

Learning activities beginning with the preparation of students physically and psychologically and deliver learning objectives. Then the teacher activating prior knowledge of students as preparation before studying the concept. The initial problem was then given to students to be completed after activities the discovery concept. Series of activity that given to students is one form of the learning trajectory application in learning. After students know the concepts studied, students worked on the preliminary problem again using the problem solving steps. Students can understand the problem with the writing down of the known elements of the problem and wrote down what is being asked of the matter. Then students can plan strategy for finding a solution by associating concepts being studied. Students can describe the model of the problems in the form of a picture or write a formula corresponding to the completion of the given problem. Students then carry out a strategy that was created based on the plans and re-examining the ways he took already is get the right solution or not.

Stages of Evaluation

Practicality is measured by student's questionnaire and teacher's questionnaire with a maximum score of 4. Based on the analysis, the results of the student response appraisal obtained a score of 3.01 with practical category. The results show the student responses on the assessment of the accuracy of language use aspect obtained a score of 3.01 with practical category, on material/content of LKS aspect obtained a score of 2.98 with practical category, aspects of the usage of LKS in learning obtained a score of 3.18 with practical category and the attractiveness of the LKS aspect obtained a score of 2.88 with a practical category.

Table 5. Analysis of Student's Respons Result

No.	Aspect of Assesment	Average Score	Category
1.	Accuracy of language use	3,01	Practical
2.	Material/Content of Student Worksheet	2,98	Practical
3.	The usage of Student Worksheet	3,18	Practical
4.	The attractiveness	2,88	Practical
Average Score		**3,01**	**Practical**

The average score of teacher's respons assessment obtained a score of 3,45 on a scale of 4 with "very practical" category. In more detail on the material aspects obtained a score of 4 in the category of very practical, on the attractiveness of the aspects of LKS obtained an average score of 3.25 with very practical category, aspects of the use of worksheets in the learning obtained a score of 3.36 with a very practical category. Based on the results of the teacher responses appraisal and students responses appraisal can be said that the learning

set has practical criteria that means to facilitate students and teachers in the learning process.

Table 6. Analysis of Teacher's Respons Sheets

No.	Aspect of Assesment	Average Score	Category
1.	Content	4	Very Practical
2.	The attractiveness	3,25	Very Practical
3.	The usage of Student Worksheet	3,36	Very Practical
Average Score		**3,45**	**Very Practical**

Assessment of effectiveness is measured through students test results in the form of problem-solving ability test with a limit value of at least 75. The test completeness problem solving skills using the description matter to determine the level of students' understanding of the material being taught. Based on test results obtained 84.34% students have reach KKM and the average value of the class achieved more than the value specified KKM is 75. Thus learning set can be said effective.

Analytical work on aspects of problem solving skills obtainable class average value of 81.81. Based on the results statistically using SPSS statistical test showed that the data were normally distributed. On normality test results using the one-sample Kolmogorov-Smirnov Asymp values obtained sig. (2-tailed) = 0.282 means greater than the significance level α = 0.05. Based on the decision criteria H_0 is acceptable if the significance value > α = 0.05. The conclusion is that the data comes from normally distributed population. The test results using the SPSS statistical normality can be seen in Figure 1.

One-Sample Kolmogorov-Smirnov Test

		NILAI
N		32
Normal Parameters[a,b]	Mean	81.8125
	Std. Deviation	9.47131
Most Extreme Differences	Absolute	.175
	Positive	.077
	Negative	-.175
Kolmogorov-Smirnov Z		.989
Asymp. Sig. (2-tailed)		.282

Figure 1. Normality Test Results Using One-Sample Kolmogorov-Smirnov

Based on the test results the SPSS using one-sample t-test, data showed that the average score of class is 81.8125 and the results showed that the level of significance < α = 0.05 so that it can be said that the average score of the class over 75. Results of SPPS indicates that the value t_{hitung} with degrees of freedom (df) = 31 is 4.069 and sig. (2-tailed) = 0.000 means smaller than the significance level 0.05. Based on the decision criteria can be said that learning set is effective with an average score of class reach more than KKM i.e. 75. The result of using SPSS statistical hypotheses testing can be seen in Figure 2.

One-Sample Test

	Test Value = 75					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
NILAI	4.069	31	.000	6.81250	3.3977	10.2273

Figure 2. Results of Hypotheses Testing Using One-Sample t-Test

After the assessment tests students' problem-solving abilities, for the analysis of problem-solving abilities gained an average percentage of problem-solving abilities by 81%. This means that students have been able to develop aspects of problem solving ability after using student worksheet developed. In more detail, the capability to understand the problem acquired a percentage of 87%. Aspects of the devise a plan capabilities obtained by percentage of 79%, the capability to carry out the plan obtained completion percentage of 80%, while the capability to look back obtain percentage of 79%. The results of the test analysis problem solving skills can be seen in Table 7.

Table 7. Analysis of Problem Solving Ability Test Results

No	Aspect of Assesment	Percentage of Achievement
1.	The ability to understand the problems	87%
2.	The ability to devise a plan	79%
3.	The ability to carry out the plan	80%
4.	The ability to look back	79%
The average percentage of		**81%**

all aspects

Based on the results of the review of the three aspects of validity, practicality and effectiveness, it can be concluded that the learning set using problem solving approach refers to the learning trajectory and problem-solving abilities orinted have reached criteria of valid, practical and effective.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the results of data analysis and discussion that has been done on learning set using problem solving approach refers to the learning trajectory, it can be concluded that: (1) a learning set developed is valid, valid criteria obtained from the RPP assessment sheet with an average score of 4,24 on a scale of 5 with very valid category while LKS assessment sheet obtained an average score of 4.15 on a scale of 5 with valid category, thus gained an average score assesment of RPP and LKS of 4.195 on a scale of 5 with valid category, (2) learning set developed is practical, practical criteria obtained through student assessment results toward the usage of LKS in the amount of 3.01 on a scale of 4 with practical category and assesment by teachers obtained a score of 3.45 on a scale of 4 with very practical category, (3) learning set developed is effective obtained through result of students' problem-solving abilities test, the average value of students' problem solving ability test at 81.81 which is greater than KKM i.e. 75 and the percentage of students that reach KKM is 84.34%, thus the learning set is effective.

Suggestion

Based on the results of the study researchers suggest the following: (1) analysis of the characteristics of students need more pay attention in order to the preparation of learning set, especially the process of formulating hypotheses students' answers can be adapted to the actual situation in the classroom, (2) learning set for the topic of Pythagorean theorem using problem solving approach refers to the learning trajectory that is developed in this study can be used in the process of learning mathematics in junior high school of class VIII, (3) other researchers can develop learning set with a variety of other approaches.

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