



## Development of Mathematic Learning Devices Through The Application of The Problem Based Learning Model to Facilitate KPMM in Number Pattern Materials

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### ABSTRACT

This research is motivated by the low ability of students to solve mathematical problems (KPMM) and the teacher has not been optimal in developing mathematics learning tools independently. The purpose of this study was to produce mathematics learning tools through the application of the Problem Based Learning (PBL) model to facilitate KPMM students of SMP Negeri 2 Pangkalan Lesung on number pattern material. This type of research is development research using the 4-D model. Learning tools developed in the form of syllabus, lesson plan (RPP) and student worksheets (LKPD) and KPMM questions. The instruments in this study were validation sheets and student questionnaires. Validation sheets consist of syllabus validation sheets, lesson plans validation sheets, and student worksheet validation sheets, while student questionnaires are in the form of student response sheets. Based on the results of the validation analysis, it shows that the device being developed is very valid. The result of the validation of the syllabus was 3.79; the average RPP score was 3.67; and the average LKPD score was 3.66. The student response questionnaire on the small-scale test showed an average percentage of 94.67% with the very practical category. The learning tools developed were valid and practical for use by students of SMPN 2 Pangkalan Lesung.

## 1. Introduction

The implementation of the curriculum is very much determined by the ability of teachers to develop learning tools, because these learning devices are implemented in daily learning practices in educational units (Sa'dun. Akbar, 2013). The learning tools used in learning are in the form of a syllabus, lesson plans (RPP), and student worksheets (LKPD).

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Based on the results of the students' initial ability test conducted by researchers at one of the junior high schools in Pelalawan Regency, namely SMPN 2 Pangkalan Lesung, on the number sequence material, it was found that students had low KPMM. Based on the data processing, the average percentage of students' error rate on the KPMM indicator was 65.15%.

The results of student work show that students are able to write down what is known but not clearly and incompletely. The sequence of steps in the problem-solving plan is well ordered but incomplete. Students also do not double-check so that the results obtained are wrong. In addition, students also did not write down the answer conclusion. This shows that the KPMM of students is very low. Therefore it is necessary to increase the student's KPMM.

Based on the description above about learning planning, the learning process, the importance of learning tools, and the low KPMM of students, an effort is needed to overcome this. One of the efforts that can be done is the need to develop mathematics learning tools that can improve student KPMM. Learning tools in the form of lesson plans and student worksheets (LKPD) were developed with the PBL learning model so that learning objectives were achieved. These learning tools need to be developed to contain realistic things to make them easier for students to understand. In order for the learning tools developed to function properly in learning, the learning tools must be valid and practical.

## 2. Methodology

The form of research carried out is development research with the term Research and Development (R&D), namely research that aims to produce certain products. This development research uses a 4-D model. This development model was suggested by Thiagarajan, Semmel, and Semmel. The four stages of this development model include define, design, develop, and disseminate (Endang, 2012). In this study, the researcher will develop a mathematics learning tool in the 2013 curriculum on number pattern material with products in the form of a syllabus, lesson plans and student worksheet developed through the PBL model. The test subjects in this study were students of class VIII SMP Negeri 2 Pangkalan Lesung. The subject of a limited trial was carried out on 6 students who were tried out in class IX of SMP Negeri 2 Pangkalan Lesung. The data collection techniques in this study were literature study and interviews. While the data analysis techniques in this study are as follows:

### 1. Analysis of data from the validator's assessment

The data to determine the validity of the product were obtained from the assessments of two mathematics teachers and lecturers, which were then analyzed (adapted from Anas Sudijono, 2011).

$$\bar{M}_v = \frac{\sum_{i=1}^n \bar{V}_i}{n}$$

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Information:

$M_v$  = mean of total validity

$V_i$  = the average validation of the i-th validator

n = number of validators

Determination of the range can be determined through the highest score minus the lowest score divided by the highest score. Based on the determination of the range, a range of 0.75 was obtained. The average analysis validation criteria used can be seen in the following table 1 (Suharsimi, 2012)

Table 1. Criteria for the Validity of Learning Devices

Interval	Category
$3,25 \leq \bar{x} < 4$	Very Valid
$2,50 \leq \bar{x} < 3,25$	Valid
$1,75 \leq \bar{x} < 2,50$	Less Valid
$1,00 \leq \bar{x} < 1,75$	Invalid

In this study, the learning device was validated by a validator, data analysis classified intervals and categories as stated as valid if it met the interval  $2.50 \leq \bar{x} < 4$ , invalid if it met the interval  $1.00 \leq \bar{x} < 2.50$

## 2. Student Response Questionnaire Analysis

Analysis of the practicality of the resulting product was obtained from the results of the student response questionnaire analysis which was presented in a table form with a Guttman scale that contained Yes and No answer choices. Analysis of the student response questionnaire data was carried out using the formula (Sa'dun, 2015):

$$V_p = \frac{Tsa}{Tsh} \times 100\%$$

Information:  $V_p$  = respondent's score

$Tsa$  = total empirical score of the respondent

$Tsh$  = the maximum expected total score

In this student response questionnaire there are statements that have positive and negative meanings. For sentences that have a positive meaning, the answer choice Yes has a value of 1 (highest score) while the answer choice No has a value of 0 (the lowest score). Meanwhile, for sentences that have a negative meaning, the answer choice is not 1, while the Yes answer is 0. Analysis of the practicality of mathematics learning tools in the form of LKPD is done by counting the number of students who choose the answer "Yes" for positive statements and choose the answer "No" for negative statements . The questionnaire criteria for student responses to the practicality of LKPD are seen in table 2 (Suharsimi, 2012).

Table 2. Criteria for KPD Practice

No.	Interval	Practicality Criteria
1.	85,01% - 100,00%	Very practical.
2.	70,01% - 85,00%	Practical
3.	50,01% - 70,00%	Less practical
4.	01,00% - 50,00%	It's not practical

In this study, the practicality of LKPD was based on the questionnaire data of the data analysis students by classifying intervals and categories as stated as practical if it met the practical interval if it met the interval, 70.01% - 85.00% was less practical for the interval, 50.01% - 70.00 % and impractical for the interval 01.00% - 50.00%.

### 3. Results and Discussion

This study uses a 4-D development model which consists of four stages, namely define, design, develop, and disseminate (Endang, 2012). This research has reached the 4-D design stage.

#### a. Definition Stage

The purpose of activities at this stage is to determine and define the requirements for developing mathematics learning tools. The define stage consists of five stages, namely:

##### 1) Preliminary analysis

In this step, what is done is that the researcher examines the applicable curriculum, determines the basic problems faced so that a solution is needed for these problems. In this study, the problem faced is the limited mathematics learning tools as a means of supporting learning in the 2013 Curriculum so that it becomes the background for the need to develop learning tools in the form of syllabus, RPP, LKPD d in the Line Pattern material to improve KPMM.

##### 2) Student analysis

Student analysis aims to determine the characteristics of students in following lessons. Student analysis is used as a reference for designing learning tools that will be developed in accordance with student characteristics. The characteristics studied are the age of the student and the abilities that students must have based on their age. Where the subjects in this study were students of class VIII SMP. Class VIII students consist of children over 12 years of age. In its development stage, junior high school students are at a very rapid stage of development in all aspects. Students over 12 years of age already have the ability to think abstractly, reason logically, can draw conclusions.

### 3) Task Analysis

In this step, what is done is to determine KD and indicators of competency achievement in the Line pattern material based on the 2013 curriculum. KD used in developing mathematics learning tools is shown in the following table 3.

Table 3. Basic Competencies in Number Pattern Material.

<b>Basic Competencies</b>
3.1 Making pattern generalization on number sequences and object configuration sequences.
4.1 Solving problems related to patterns in number sequences and object configuration sequences.
3.1 Making pattern generalization on number sequences and object configuration sequences.
4.1 Solving problems related to patterns in number sequences and object configuration sequences.

### 4) Concept analysis

Concept analysis aims to identify, detail, and systematically arrange concepts relevant to the material to be taught, namely Line Patterns. This analysis is a procedural set to determine the content of a teaching. The results of the analysis are used as a guide in preparing the mathematics learning tools that will be developed.

### 5) Specification of learning objectives

In this step, what is done is to describe the learning objectives that are in accordance with the results of the concept analysis then integrated with the preparation of the learning tools to be developed. The objectives were developed based on ABCD. The learning objectives of Sequence Patterns are:

a) Through discussion and group learning activities through the process of observing, questioning, gathering information, reasoning and communicating, it is hoped that students will cooperate carefully in solving problems and have curiosity about the number sequence material and can determine the pattern in a sequence correctly, if given a sequence of numbers. appropriately;

b) Through discussion and group learning activities through the process of observing, questioning, gathering information, reasoning and communicating, it is hoped that students will work closely in solving problems and have curiosity about the number sequence material and can make number sequence patterns correctly if given a configuration object appropriately;

c) Through discussion and group learning activities through the process of observing, questioning, gathering information, reasoning and communicating, it is hoped that students will work closely in solving problems and have curiosity about the number sequence material and be able to find the nth syllable formula of the number sequence correctly, when given a sequence of numbers.

d) Through discussion and group learning activities through the process of observing, questioning, gathering information, reasoning and communicating, it is

hoped that students will work closely in solving problems and have a curiosity about the number sequence material and be able to find the value of the  $n$ th syllable and the value of the  $n$ th syllable.  $-n$  object configuration of the sequence of numbers if given a sequence of numbers exactly

## **b. Design Stage**

The researcher designed the syllabus, lesson plans, and student worksheet based on the results of the research stages and data collection. Researchers designed learning tools developed based on the define stages. Researchers designed learning tools consisting of a syllabus, lesson plans and student worksheets. At this stage there are three steps taken, namely

### 1. Formulation of criteria

The criteria for learning devices developed are adjusted to Permendikbud No. 22 of 2016. The criteria for the syllabus based on Permendikbud No. 22 of 2016 include syllabus identity, core competencies, basic competencies, subject matter, learning activities, assessment, time allocation and learning resources.

RPP criteria based on Permendikbud No. 22/2016 include: (1) RPP identity; (2) KD and competency achievement indicators (GPA); (3) learning objectives; (4) learning materials; (5) learning approaches, models and methods; (6) learning media; (7) learning resources; (8) learning activities; and (9) assessment of learning outcomes.

### 2. Format selection (format selection)

The format of the tools developed in this study is the format of the tool set according to Permendikbud Number 22 of 2016 using the PBL model. At this stage the researcher designed a syllabus for the odd semester SMP / MTs VIII class on the subject matter of number patterns with a time allocation of 10 JP in KD 3.1 to generalize patterns in number sequences and object configuration sequences and 4.1 to solve problems related to patterns in number sequences and configuration sequences object.

Researchers develop lesson plans with RPP components referring to Permendikbud Number 22 of 2016, which includes the name of the school, subjects, classes / semesters, subject matter, learning materials, time allocation, core competencies, basic competencies, competency achievement indicators, learning objectives, learning materials, learning approaches and methods, media, learning tools and resources, learning activities, and assessment of learning outcomes. Learning activities consist of preliminary activities, core activities and closing activities. The core activities are structured based on a scientific approach with the activities of observing, questioning, gathering information, reasoning, and communicating. The draft RPP compiled is as follows.

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The LKPD designed in this study uses a problem-based learning model, so that it can facilitate students in conducting investigations. Researchers designed LKPD on Number Pattern material for four meetings consisting of covers, columns as space for students to write answers and supporting pictures. The LKPD cover is designed to contain the subject matter title, group identity column and instructions.

### 3. Initial design

In this step, the researcher made a mathematics learning tool design which included a syllabus design, lesson plan design, and student worksheet design.

#### a. Syllabus design

The results of the analysis of the learning tools show that the syllabus used by the teacher consists of KD components, learning materials, and learning activities for five meetings. Researchers designed a syllabus on trigonometric material for four meetings which contained components of identity, KI, KD, learning materials, indicators of competency achievement, learning activities, assessments, time allocation, and learning resources.

#### b. RPP draft

The results of the learning device analysis show that one lesson plan is prepared for five trigonometric material meetings consisting of identity, learning objectives, basic competency indicators, competency achievement indicators, learning materials, methods and models, learning resources, learning activities, and assessments. The researcher designed the lesson plan on the line pattern material for four meetings, each of which contained an identity component; KD and indicators of competency achievement; learning objectives; learning materials; learning models, approaches and methods; media, tools and learning resources; Learning Activities; and assessment.

#### c. LKPD design

The results of the analysis of learning devices show that the worksheets used by students have not been able to facilitate students to construct their knowledge. Researchers designed LKPD using the PBL model, so as to facilitate students in conducting investigations. The researcher designed the LKPD on the material of the line pattern for four meetings consisting of covers, columns as a space for students to write answers and supporting pictures.

### **c. Development Stage**

Researchers develop learning tools based on a draft that has been compiled. The learning tools developed consisted of a syllabus, lesson plans and student worksheets using a problem-based learning model on Number Patterns material.

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### a. Syllabus Development.

The researcher developed a syllabus on the number pattern material for the four meetings which contained components of identity, KI, KD, learning materials, indicators of competency achievement, learning activities, assessment, time allocation, and learning resources. The syllabus is developed based on the draft that has been prepared. The researcher developed a syllabus on number pattern material for the four meetings. The results of developing the syllabus can be seen in the following figure 1.

SILABUS	
Sekolah	: SMP Negeri 2 Paokalan Lesung
Mata Pelajaran	: Matematika
Kelas/Semester	: VIII/Ganjil
Materi Pokok	: Barisan Bilangan
Alokasi Waktu	: 10 x 40 menit
KI-1	: Menghargai dan menghayati ajaran agama yang dianutnya.
KI-2	: Menghargai dan menghayati perilaku jujur, disiplin, tanggung jawab, peduli (toleransi, gotong royong), santun, percaya diri, dalam berinteraksi secara efektif dengan lingkungan sosial dan alam dalam jangkauan pergaulan dan keberadaannya.
KI-3	: Memahami pengetahuan (faktual, konseptual, dan prosedural) berdasarkan rasa ingin tahunya tentang ilmu pengetahuan, teknologi, seni, budaya terkait fenomena dan kejadian tampak mata.
KI-4	: Mencoba, mengolah, dan menyaji dalam ranah konkret (menggunakan, mengurai, merangkai, memodifikasi, dan membuat) dan ranah abstrak (menulis, membaca, menghitung, menggambar, dan mengarang) sesuai dengan yang dipelajari di sekolah dan sumber lain yang sama dalam sudut pandang/teori.

Figure 1. The syllabus that has been developed

### b. RPP development.

The researcher developed the lesson plan using the PBL model on the number pattern material. Researchers develop lesson plans based on a draft that has been compiled. Researchers develop lesson plans on Number Pattern material for the four meetings with components. . The competency achievement indicators in the RPP are adjusted to the competency achievement indicators in the syllabus for each meeting (Table 4).

Table 4. KD and Competency Achievement Indicators in RPP

Meeting	Basic competencies	Indicators of Competence Achievement
The first meeting	3.1 Making pattern generalization on number sequences and object configuration sequences	3.1.1 Determine the pattern in a sequence of numbers.
	4.1 Solving problems related to patterns in number sequences and object configuration sequences	4.1.1 Solving problems related to the pattern in the sequence of numbers
2nd meeting	3.1 Making pattern generalization on number sequences and object configuration sequences	3.1.2 Determine the pattern of an object configuration.
	4.1 Solving problems related to patterns in number sequences and object configuration sequences	4.1.2 Resolves a problem related to the pattern in the object configuration array.



3rd meeting	3.1 Making pattern generalization on number sequences and object configuration sequences	3.1.3 Determine the formula for the nth term using a number sequence and object configuration.
	3.1 Solving problems related to patterns in number sequences and object configuration sequences	4.1.3 Solving the problem related to the nth term formula by using the number sequence configuration object
4th meeting	3.1 Making pattern generalization on number sequences and object configuration sequences	3.1.4 Determine the value of the nth term using a number sequence configuration object.
	3.1 Solving problems related to patterns in number sequences and object configuration sequences	4.1.4 Solving a problem related to the nth term using a number sequence configuration object.

c. LKPD development.

Researchers develop LKPD based on a draft that has been prepared. LKPD is prepared for number pattern material which consists of four meetings. Activities in LKPD are arranged by referring to the Problem Based Learning Model stage. LKPD is arranged consisting of covers, columns as space for students to write answers and supporting pictures. The LKPD developed on observing and understanding the problem is given related to the learning material. The problems presented are related to the problems in the problem orientation column. The column for observing and understanding the problem can be seen in the following figure 2.



Figure 2. Column to observe and understand the problem

#### **d. The spread stage.**

At this stage, the researcher reports the results of the study with the title developing mathematics learning tools using the Problem Based Learning Model to facilitate Mathematical Problem Solving Ability in the research results seminar. The research articles are then published in journal form

#### **4. Conclusion**

Based on the results and discussion, this study resulted in a mathematics learning tool developed using the Problem Based Learning model to facilitate KPMM for grade VIII students of SMPN 2 Pangkalan Lesung on number pattern material that has met valid criteria, the LKPD developed uses a problem based learning model to facilitate class student KPMM VIII SMPN 2 Pangkalan Lesung on number pattern material has met the valid and practical criteria.

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