

DEVELOPMENT OF PROBLEM-BASED LEARNING-BASED MODULES ON SEQUENCE AND SERIES MATERIAL FOR GRADE XI AT SMA NEGERI SEMANGUS

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ABSTRACT

This research aims to produce a Mathematics Module based on Problem-Based Learning (PBL) on sequence and series material for grade XI SMA Negeri (State High School) Semangus that is valid, practical and has potential effects. The research method uses the stages of the ADDIE development model, which consists of the five stages: analysis, design, development, implementation, and evaluation. Data collection techniques were carried out through interviews, observations, questionnaires, and tests, with the research subjects including validators (linguist experts, material experts, and media experts), mathematics teachers, and students of grade XI SMA Negeri Semangus. Based on the results of data analysis, it shows that the Aiken's V value from the experts obtained a total of 0.90 with a very valid category. In the practicality test, educators and students obtained an overall of 90.16 in the very practical category. The results of the potential effect test through tests given to 30 students showed that 26 students (86.7%) were in the completed category and 4 students (13.3%) were in the incomplete category. So it can be concluded that the problem based learning mathematics module developed in this research is declared valid, practical and has potential effects.

Keywords: Development, Module, PBL, Sequence and Series

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INTRODUCTION

Mathematics learning is a series of teacher activities in providing instruction to students to develop mathematical concepts and principles with their own abilities through an internalization process or guided direction (Persada, 2016). The target of learning mathematics is that students are expected to be able to think logically, critically and systematically. In fact, mathematics is often considered a subject that is difficult to understand or understand. This can be seen from the unsatisfactory learning outcomes of students. So far, students generally only have to memorize formulas to solve math problems. This is because mathematics is abstract and requires understanding concepts (Novitasari, 2016). The learning that is usually implemented so far is still centered on educators, students are passive and less involved in learning. Another influencing factor is that the teaching materials used are less interesting (Magdalena et al., 2020).

Based on interviews and observations conducted with grade XI mathematics teachers at SMA Negeri Semangus. on Thursday 09 November 2023, who stated that while teaching he still used teaching materials in the form of printed books. The printed books used are monotonous, less interesting and do not suit the needs of students. The printed book is only used as a guide for the teacher while students can only hear and note down what the teacher has explained. So, students are less interested and understand in learning in class because students only tend to listen and note down what the teacher has explained. In the learning process, students only rely on the information provided by the teacher without trying to look for other learning sources. He also stated that in the mathematics learning process, especially in sequence and sequence material, most students did not understand the problems given.

Researchers also received information from mathematics subject teachers at SMA Negeri Semangus that learning was still unsatisfactory, including: (a) teachers in the classroom used lecture and question and answer methods; (b) student motivation is still low as seen from the lack of enthusiasm in the mathematics learning process, as well as the lack of willingness to think in solving problems given by the teacher; (c) there is no mathematics module available at SMA Negeri Semangus but only printed books are available at school.

The results of these students' abilities depend on the conditions during which the learning activities take place. Many factors influence students' abilities, one of which is the teaching materials used (Saryani et al., 2023). Students really need interesting teaching materials that can make it easier for them to remember the learning material. One of them is teaching materials in the form of modules because they can make it easier for students to remember the learning material (Rohmaini et al., 2020).

Problem based learning modules are one of the development concepts to improve problem solving abilities in the learning process (Andayani & Pratama, 2022). The developed module is given steps based on indicators of mathematical problem solving ability, so that the module can be used in each phase of the problem based learning model. The problems presented in the module are also provided with steps to solve them according to the Problem Based Learning (PBL) model phase. Problem based learning modules are very important to facilitate students' mathematical reasoning abilities, so that with or without the help of teachers students can solve problems based on the problem based learning model. The impact of using problem-based learning modules can improve student characteristics and students' mathematical reasoning abilities and can help teachers not to repeatedly explain initial concepts to students. Apart from that, using PBL modules can improve critical thinking skills, foster student initiative in learning, internal motivation to learn and can develop interpersonal relationships in group work (Utami & Amidi, 2022).

Based on the previous explanation, a solution is really needed in the form of learning that requires a scientific process so that students independently construct their knowledge and can have an impact on their learning outcomes. One of them is making teaching materials in the form of modules, because modules can activate students in the learning process, help students develop concepts. Train students in discovering and developing process skills. As a guide for educators and students in carrying out the learning process combined with the Problem Based Learning model. Because to improve student learning outcomes, it is necessary to develop modules. The author plans to develop a PBL based module on sequences and series material of grade XI in SMA Negeri Semangus.

The results of research conducted by Angraini & Masykur, (2018) with the title of developing a mathematics module based on the problem based learning model on the main material of trigonometry for high school. The results of this research show that the problem based learning mathematics module on the main subject of trigonometry has been developed using 7 stages, namely potential and problems, data collection, product design, product validation, product revision, product testing and product revision, while based on research

results from Nofri, Rena & Erdawati., (2021) with the title of developing a module based on problem based learning in grade VIII SMP statistics material. The results of this research show validity of 85.29%, practicality for students 88.97% and practicality for teachers 98.82%.

Based on the description above, in this research a Mathematics Module based on problem based learning will be developed to improve students' problem solving abilities.

METHOD

The development method used in this research is Research and Development (R & D) using the ADDIE development model. Based on the ADDIE development model, there are 5 stages that this research goes through, including analysis, design, development, implementation and evaluation (Sugiono, 2015). The stages of the ADDIE model are implemented as follows:

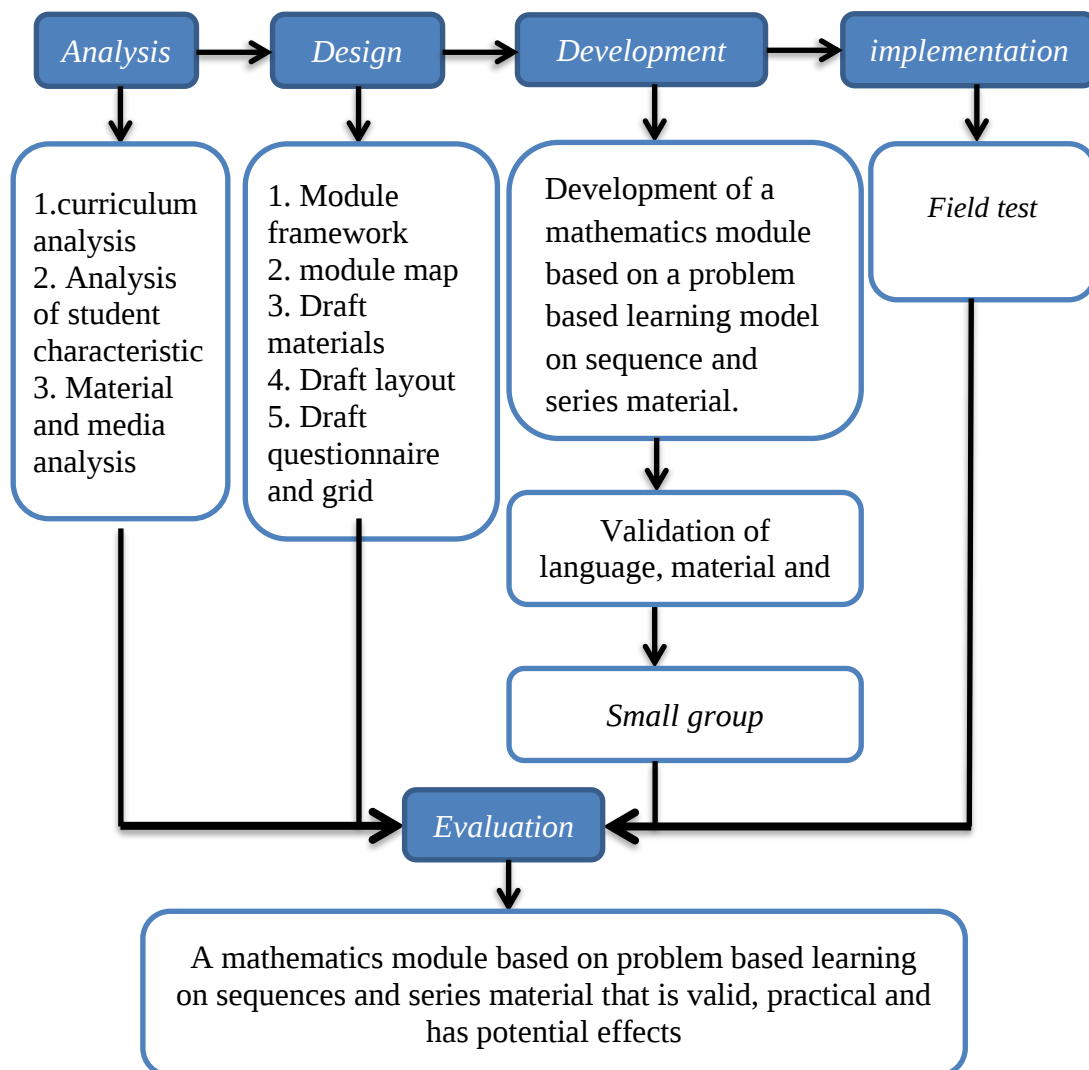


Figure 1. Module Development Plan

1. **Analyze**

The analysis stage is identifying a problem and need obtained from the school (Nuraeni et al., 2020). The analysis stage is the most important step in the ADDIE model stage because the analysis stage is a pre-planning stage for product development. This analysis stage includes three things, namely competency or curriculum analysis, student character analysis, and media analysis.

2. **Design**

The design stage includes the design of the product to be developed. At this stage, the module begins to be designed, which is developed according to the results of the analysis carried out previously. This stage is carried out by determining the elements needed in the module, such as creating a module framework, creating a module map, drafting materials, draft layout, and preparing instruments that will be used to assess the module being developed. The questionnaire assessment instrument used is prepared taking into account aspects of the product assessment to be developed.

3. **Development**

The development stage is the stage that produces a design that becomes real or makes a product and validates it which is carried out by experts, consisting of language experts, material experts and media experts (Kharisma & Asman, 2018). At the development stage, user practicality of the product being developed is also carried out. Practicality data is obtained from teacher and student assessments. This development consists of several stages including: product creation, validation tests, revisions, and practicality tests. The development stage is carried out to produce valid and practical learning in testing the practicality of teaching modules on sequences and series material. This is in line with what was stated by (Lidia et al., 2021) This development stage aims to modify the product being developed by making revisions before it becomes a valid and practical product so that it can be used in the learning process.

- a) Product Manufacturing
- b) Validation test

Table 1. Value Conversion Guidelines *Aiken's V*

Interval	Category
$0,80 < V \leq 0,100$	Very Valid
$0,60 < V \leq 0,80$	Valid
$0,40 < V \leq 0,60$	Fairly Valid
$0,20 < V \leq 0,40$	Less Valid
$0 < V \leq 0,20$	Very Invalid

Based on table 1, it can be concluded that the PBL mathematics module is declared valid if the average score obtained is $V \geq 0,60$.

- c) Practicality test

Table 2. Practicality Score Average Conversion Guidelines

Interval	Category
0-21	Impractical
21-41	Less Practical
41-60	Quite Practical
61-81	Practical
81-100	Very Practical

From table 2, it can be concluded that the mathematics learning module based on PBL is declared practical if the average score obtained is $P \geq 61$.

4. **Implementation**

The implementation stage is the stage after carrying out validation tests and practicality tests where trials at this stage are carried out by researchers (Hardianto, 2020). At this implementation stage, the results of the development are applied in learning to determine the potential effects of the module in the learning process. The implementation stage was carried out to assess whether or not this module was suitable for use by grade XI students at SMA Negeri Semangus. To find out the potential effects of the module, a large group trial (field test) is carried out by carrying out tests or working on the questions that have been given.

5. **Evaluation**

The evaluation stage includes formative evaluation and summative evaluation. Formative evaluation is carried out at each stage by the researcher with the help of the supervisor, the evaluation takes the form of input at each stage of development. Meanwhile, summative evaluation is carried out at the large group trial stage (field test).

Calculate the validity analysis of the average score from all aspects assessed using the aiken, s v formula (Azwar, 2012) following:

$$v = \frac{\sum s}{n(c - 1)}$$

Information:

v = v aiken validity index

$s = r - lo$

r = the number given by the validator

lo = lowest assessment number

n = number of raters

c = highest rating number

Calculating practical analysis of teachers and students using formulas (Susanti & Sholihah, 2021) following:

$$P = \frac{\text{total score resulting from data collection}}{\text{Maximum Score}} \times 100 \%$$

Calculate potential effect analysis using the formula (Norsanty & Chairani, 2016) following:

$$p = \frac{T}{N} \times 100\%$$

Information:

P = Classical Completion Percentage

T = Many Students Complete

N = Many Students

Data collection techniques were carried out through interviews, observations, questionnaires and tests with the research subjects including validators (linguist experts, material experts and media experts), mathematics teachers, and grade XI students of SMA Negeri Semangus.

RESULTS AND DISCUSSION

This research produces a product in the form of a mathematics module on sequences and series with the Problem Based Learning (PBL) model for grade XI high school students. The research procedure used is ADDIE research and development which goes through several stages, namely: analysis stage, design stage, development stage, implementation stage and evaluation stage. With the aim of producing products that are valid, practical and have potential effects by measuring learning outcomes and can be used to assist the learning process. The following is an explanation of the steps of the ADDIE learning model:

1. Stage Analyze

The analysis stage is the initial stage for conducting development research. This analysis stage includes three things, namely competency or curriculum analysis, student character analysis, and media analysis. The analysis stages carried out are as follows:

a) Curriculum/competency analysis

The guidelines used for curriculum analysis are 2013 (K13) and describe basic competencies and learning indicators.

b) Analysis of student characteristics

According to Yuman et al, (2023) Student analysis aims to identify the characteristics of students in the learning process. Analysis of student character is carried out by identifying the character of students who will use PBL based modules. Analysis of students is carried out by asking the teacher who teaches the subject in that class by means of observation. It can be concluded that teaching materials are needed that attract students to increase their interest in learning, by linking everyday life to learning. Meaning that teaching materials can be used in the learning process to increase students' interest and overcome ineffective study time.

c) Media analysis

Media analysis was carried out during initial observations by means of direct interviews with mathematics subject teachers. Based on the results of observations carried out on 09 November 2023, researchers obtained information that in mathematics lessons the teaching materials used were still limited. For example, they still use printed teaching materials such as printed books. Apart from that, during the learning process, students can only watch and pay attention to the teacher explaining how to use the teaching materials. Therefore, teaching materials are needed that are able to involve students actively and educatively to support learning activities.

2. Stage Design

The implementation of the design stages for developing PBL modules is as follows:

a) Develop the module framework

The teaching material developed in this research is a module for students which consists of three parts, namely, the beginning, the content and the end. The initial part of the module consists of the front cover, foreword, table of contents, core competencies and basic competencies, module development and about PBL, module description, instructions for use, concept map, and (PBL) syntax.



Figure 2. Module Cover



Figure 3. PBL Syntax

b) The initial design of the module is based on PBL

The initial design of the PBL module was arranged according to the characteristics of the material used, namely rows and series. The language used in this module is Indonesian and the application used in developing this module is Microsoft Office Word 2010.

c) Preparation of research instruments and questionnaires

Preparation of research instruments as a tool for collecting research data. After the research instrument is prepared, the instrument is consulted with the supervisor so that it can be used to collect research data.

3. Stage Development

At the product development stage, the steps taken are creating teaching modules, validating teaching modules from experts, practicality questionnaires for educators and students, and product trials. This is in line with what was stated by (Lidia et al., 2021). This development stage aims to modify the product being developed by carrying out revisions before it becomes a valid and practical product so that it can be used in the learning process.

a) Product manufacturing

The teaching module creation stage is carried out by presenting row and series material. The sequence and series teaching module is divided into 2 learning activities, namely arithmetic sequences and arithmetic series. The contents of the teaching module include material descriptions, problem examples, problem solutions, group discussions, and competency tests.

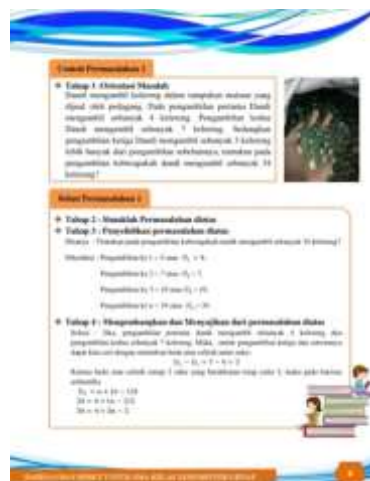


Figure 4. Examples of Problems in the Module

b) Validation of teaching modules

Validation is carried out by experts to perfect the teaching module products developed in terms of language, materials and media

Table 3. Assessment Results of All Validators

No	Validator	Number of Question Items	Score obtained	Average Score	Criteria
1	Linguist	12	41	0,85	Very Valid
2	Materials Expert	14	51	0,91	Very Valid
3	Media Expert	16	60	0,94	Very Valid
	Amount	42	152	0,90	Very Valid

c) Practicality Questionnaire for teachers and students

The practicality test was carried out at Semangus State High School by mathematics subject teachers and students (Small Group) consisting of 6 grade XI IPA 2 students who were taken to have heterogeneous abilities. Respondents first looked at the mathematics module provided by the researcher.

Table 4. Module Practicality Questionnaire Results

No	Response assessment	Maximum value	Value obtained
1	Teacher	65	57
2	Small group students	240	218
	Amount	305	275
	Product feasibility results	90,16%	
	Criteria	Very Practical	

4. Stage Implementation

Implementation is a field test which aims to see the learning outcomes of students before and after using the teaching module on rows and rows material for grade XI IPA 2 students at SMA Negeri Semangus, totaling 30 students. The large group trial aims to determine the potential effects of the PBL module. To determine the potential effect of a

mathematics module based on a PBL model using sequence and series material that has been developed, an analysis of student learning outcomes was carried out on 30 students.

Table 5. Student Learning Outcomes

The Number of Students	Percentage (%)	Category
26	86	Complete
4	14	Incomplete
30	100%	

5. Stage Evaluation

The evaluation results are used to provide feedback to users of the media that will be developed. At this stage the final revision of the media being developed is also carried out. Revisions are made according to evaluation results or needs that cannot be met by the product being developed.

a) Product Revision

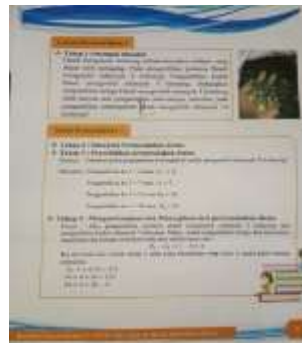


Figure 5. Before Revision Mistyping the name of the word (Dandi)



Figure 6. After Revision, it was replaced with capital letters (Dandi)

Teaching materials are all materials that are arranged systematically, which display a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and reviewing learning implementation. According to Aderibigbe (2018) Teaching materials are a set of subject matter that refers to the curriculum used in order to achieve predetermined competency standards and basic competencies. Meanwhile, according to Rahmawati (2020) Teaching materials are all forms of materials used by teachers to carry out teaching and learning activities.

Modules are books created with the aim of enabling students to learn independently with or without an educator (Vera & Maryaningsih, 2021). According to Anugrahana (2019) A module is a teaching guide that is prepared systematically and interestingly which includes

material content, methods and evaluation that can be used independently. Therefore, a module must contain learning that is appropriate to student characteristics and able to make students experience meaningful learning (Ramadhany & Prihatnani, 2020). A module is a package of alternative learning programs that are planned and designed to support students in completing certain objectives that can be studied individually with limited assistance from teachers or other people so as to make students experience meaningful learning (Hayu et al., 2023). The use of modules is expected to increase student independence and help students obtain sufficient learning resources without having to look for other learning sources, making it easier for students and saving time in the learning process by using the Problem Based Learning (PBL) model.

Problem-based learning is a learning model that presents contextual problems so that it can stimulate students to learn in classes that apply problem-based learning. Students work in teams to solve real world problems (Sargaling et al., 2022). With (PBL), meaningful learning will occur. Students learn to solve problems so they will apply the knowledge they have or try to find out the knowledge needed. Learning can become more meaningful and can be expanded when students are faced with situations where concepts are applied (Sofyan & Komariah, 2016). In problem based learning situations, students integrate knowledge and skills simultaneously and apply them in relevant contexts (Maulida, 2022). Problem based learning can improve critical thinking skills, foster students' initiative in working, internal motivation to learn and can develop interpersonal relationships in group work (Utami & Amidi, 2022).

Product content validation was carried out by three experts, namely language experts, material experts and media experts. Experts were asked to validate the products in the form of modules produced. According to Irfan (2018) All improvements or suggestions from experts are taken into consideration when revising the product. There are three validation sheets, namely language validation sheets, material validation and media validation. The practicality of the module developed can be seen based on the results of the practicality sheet filled in by the mathematics subject teacher and a small group test consisting of 6 students. Then in prototype 2 the module was revised based on the results of the analysis of teacher and student practicality sheets so as to produce the module as a final product that was valid and practical (Reskiawan & Agustang, 2021). To find out the potential effects of the module, a large group trial (field test) is carried out by carrying out tests or working on the questions that have been given. In this trial, it will be tested on 30 students from grade XI at SMA Negeri Semangus.

CONCLUSION AND SUGGESTIONS

This research aims to develop a Problem Based Learning Module with Sequence and Series Material that is valid, practical and has potential effects. The teaching modules developed use the ADDIE method, namely analysis, design, development, implementation and evaluation. Based on the research results, it was found that the validity carried out by the validators (linguist experts, material experts, media experts) obtained an overall score of 0.90 which was categorized as very valid. The practicality of the modules developed based on teacher and student responses obtained an overall percentage of 90.16 in the very practical category. The potential effect of the module developed on test questions for 30 students was data obtained that 26 students with a completeness percentage (86.7%) were declared complete and 4 students with a completeness percentage of 13.3% were declared incomplete.

The suggestions for future researchers to develop mathematics modules based on problem based learning to facilitate students' achievement and mastery of mathematical concepts are that further refinement is needed so that this teaching module is even better and it needs to be developed further on other, broader material so that the mathematics learning material is fulfilled. It is hoped that future researchers can use other strategies based on the

characteristics of students in each school in developing teaching modules, so that they can produce findings that contribute to the development of educational science.

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