PRELIMINARY STUDY ON THE DEVELOPMENT OF PROJECT-BASED LEARNING MODULE TO IMPROVE STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITY

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ABSTRACT
Mathematical problem solving skills are important for high school students, but are still low. The contributing factor is that learning does not emphasize problem solving and involve students. Teaching materials are not suitable with students' characteristics. Teacher skills in developing problem solving-based learning are still low. This study aims to develop a learning module based on Project Based Learning (PBL) to improve the mathematical problem solving skills of high school students in grade XI on the sequence and series topic. Testing the effectiveness of the PBL module on improving students' mathematical problem solving skills. This research uses the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model to develop the PBL module. In the analysis stage, data were collected through observation, questionnaires, interviews, and tests to find out students' problems in learning the material of sequence and series. The test results of students' mathematical problem solving skills showed that 91% of students had low mathematical problem solving skills. At the design stage, the PBL module was designed by considering the results of the student needs analysis and the characteristics of the sequence and series material. This module contains various learning activities that involve students actively in solving problems related to everyday life.In the next stage, the PBL module that has been designed will be implemented in the experimental class and tested for its effectiveness in improving students math problem solving ability.
Keywords: Mathematical Problem-Solving Ability, Project Based Learning, Learning Module, Sequences and Series

INTRODUCTION

Problem solving is the process of identifying, analyzing, and interpreting a problem using certain methods or techniques. Problem solving can also be interpreted as a process of understanding the problem, planning problem-solving strategies, implementing problem-solving strategies and evaluating the results obtained from problem solving (Ayuso, 2020) Likewise, in mathematics learning, mathematical problem solving is defined as a critical process that involves analysis, reasoning and exploration of solutions (Annizar et al., 2020) to overcome mathematical problems (Lahinda & Jailani, 2015). Problems in mathematics can be in the form of story problems or non-routine problems and

applications of mathematical concepts in everyday life whose solutions are not yet clearly known (Seidouvy, 2020). All problems in mathematics cannot necessarily be said to be a problem, it is said to be a problem if it cannot be solved immediately but must go through a reasoning process (Vicente et al., 2022). Mathematical problem solving requires critical thinking skills, a deep understanding of mathematical concepts, problem solving skills, perseverance and confidence in applying mathematics to real contexts (Mumu et al., 2021). Mathematical problem solving can also create new ideas, find techniques and even be able to create new products (Kouvela et al., 2017).

Mathematical problem solving plays an important role in mathematics learning because it plays a major role in improving the quality of mathematics learning. Mathematical problem solving is an integral part of mathematics learning, so that problem solving and mathematics learning cannot be separated (Cai & Lester, 2023). Here are several reasons why mathematical problem solving is very important in mathematics learning, namely problem solving is part of mathematics, mathematics has application and application, there is intrinsic motivation inherent in mathematical problems, teaching students to develop mathematical problem solving skills (Annizar et al., 2020).

Mathematical problem solving ability is the ability of individuals or groups to identify, analyze and analyze problems effectively and efficiently. Problem solving ability is also defined as the ability to collect relevant information, analyze the situation, identify the root of the problem, develop strategic solutions and implement appropriate actions to overcome the problem (Warsita, 2018). Mathematical problem solving skills are not just understanding concepts but being able to apply them in real life (Kouvela et al., 2017). In the process of learning mathematics, the first person to become a *problem solver* is the teacher. Teachers must develop students' mathematical problem solving skills by teaching appropriate problem solving strategies, providing sufficient time, and repeating periodically for math problems that are quite difficult (Simamora & Saragih, 2019). Thus, student activities in learning mathematics can be directed to solve problems, students not only listen, record, and memorize subject matter, but students actively think, communicate, search and process data and conclude (Rahlinda et al., 2022).

Mathematical problem solving skills are very important for students. Mathematics education in the 21st century emphasizes the the importance of mathematical problem solving skills in learning (Karaca-atik et al., 2023). In line with that, the objectives of mathematics learning in secondary schools in Indonesia emphasize the importance of mathematical problem solving skills for students as contained in Permendikbud Number 22 of

2016. In addition, Permendikbud No. 37 of 2018 also requires mathematical problem solving skills as a basic competency that students must have. The mathematical ability that students must have which is related to the learning objectives of mathematics is the ability to solve mathematical problems (Kemdikbudristek, 2016). Increasing the ability to solve mathematical problems can improve mathematics learning outcomes and help solve various problems in other subjects and in everyday life (Agustami, et al., 2021).

Facts in the field show that students' mathematical problem solving skills are low and not as expected and need special attention. This can be "proven by the results of PISA and TIMSS which can be used as benchmarks in knowing the ability to solve mathematical problems because the cognitive aspects assessed in PISA and TIMSS are the ability to solve mathematical problems based on real-life contexts (Banjarnhor, 2018). The 2018 PISA results show that Indonesia ranks 73 out of 78 countries with a score of 379 from an international average score of 489 (OECD, 2018). Meanwhile, the TIMSS results show that Indonesia is ranked 45 out of 50 countries (Mullis et al., 2023). The low mathematics results in Indonesia are caused by several factors, including: a) students experience difficulties in learning mathematics, causing fear in learning mathematics. b) mathematics learning seems to be less touched on the substance of problem solving. c) students tend to memorize mathematical concepts so that students' ability to solve problems is very lacking. d) students are always lazy and do not want to look for their own ideas. e) Most teachers teach with a model that is not in accordance with the material being taught, f) mathematics learning in schools, so far, is still dominated by conventional learning with its teaching paradigm. g) conventional learning learned is not able to help students get out of problems. h) in answering a problem students often focus on one problem, 2016). f) learning mathematics in schools, so far, is still dominated by conventional learning with its teaching paradigm. g) conventional learning that is learned is not able to help students get out of problems. h) in answering a problem students are often focused on one of the most correct answers and solve problems by focusing on example problems without being able to think of possible answers or various ideas in solving the problem (Mahdiyanto et al., 2016; Azizah & Haerudin, 2021). Thus it can be concluded that the low mathematics results in Indonesia are caused by mathematics learning that does not emphasize problem solving and does not involve students actively.

Based on the problems that have been described, it can be seen how important teaching materials are that support the improvement of students' mathematical problem solving skills, so the researchers intend to conduct a preliminary study on the development of *project-based learning-based* modules to improve mathematical problem solving skills

on the material of Sequence and Series for class XI students of Ibnu Siena Mulia Tasikmalaya Senior High School.

METHODS

Preliminary research is an important step in research into the development of sequence and series project-based learning (PjBL) modules. The aim is to understand the learning conditions in schools and the needs of teachers and students regarding sequence and sequence material. This preliminary research was conducted to obtain input for the development of a project-based learning (PjBL) module which aims to improve students' mathematical problem solving abilities. It is hoped that the results of this preliminary research will provide a clear picture of the needs of teachers and students for the PjBL module, as well as the problems faced in learning sequence and series material. This information will then be used to develop a PjBL module that is effective and meets user needs.

This research involved 3 teachers and 54 students from SMAS Ibnu Siena Mulia Cikoneng and SMAS Ibnu Siena Mulia Tasikmalaya from January to February 2023. The data collection techniques used were tests, observations and questionnaires. The data collected includes document analysis (RPP, syllabus, and teaching materials), teachers' and students' needs for the PjBL module, profiles of students' initial mathematical problem solving abilities, teachers' and students' perceptions about the importance of mathematical problem solving abilities, and students' learning experiences in line material. and series.

Questionnaires were used to collect data from 3 teachers and 54 students. The statements in the questionnaire are designed to measure the suitability of the PjBL module to the needs of teachers and students, the awareness of teachers and students about the importance of mathematical problem solving abilities, and the level of difficulty faced by students in learning sequence and series material. Meanwhile, unstructured interviews were conducted with 3 teachers to dig deeper into their views on effective mathematics learning, the obstacles they face in learning sequence and series material, as well as their hopes for the PjBL module.

The data collection instruments used were document review sheets, questionnaire sheets, and test sheets for students' initial mathematical problem solving abilities. Meanwhile, the methods used in this preliminary study are document analysis, needs analysis, and initial profile analysis of mathematical problem solving skills.

The first document analysis carried out was the lesson plan (RPP) analysis. The aim is to identify basic competencies, indicators, learning objectives, learning media and resources, learning activities, learning models, and sequence and series material topics. The way to do this is to collect lesson plans from SMAS Ibnu Siena Mulia Cikoneng and SMAS Ibnu Siena Mulia Tasikmalaya, read and note down basic competencies, indicators and learning objectives, identify media and learning resources, analyze learning activities, review learning models and note down the topics of class material and row. Second, analysis of school teaching materials. Objective: To find out learning activities and indicators of mathematical problem solving abilities. The steps taken are collecting school teaching materials, analyzing learning activities, identifying learning models and assessing indicators of mathematical problem solving abilities.

Apart from that, the needs analysis carried out on teachers and students with the aim of ensuring the need for PBL modules was carried out in steps, namely conducting questionnaires or interviews with teachers and students, collecting data about learning obstacles and analyzing data to see the need for PBL modules. Meanwhile, initial profile analysis of mathematical problem solving skills was carried out with the aim of knowing the profile of students' mathematical problem solving abilities. The steps are to test mathematical problem solving abilities and analyze the test results.

The results of this preliminary study will be used to develop a PBL module that suits the needs of teachers and students, ensure that the PBL module contains appropriate learning materials and activities to improve students' mathematical problem solving abilities and assess the effectiveness of the PBL module in improving students' mathematical problem solving abilities.

RESULTS AND DISCUSSION

The test data given by the math teacher during math learning that students can do routine problems given by the teacher as shown in the following figure.

(i)

English Version:

50, 48, 46, …
Determine the sum of the first 10 terms.

Answer:

$$S_n = \frac{n}{2}(2a + (n-1)b)$$
$$S_n = \frac{10}{2}(2 \cdot 50 + (10-1)(-2))$$
$$= 5(100 + (9)(-2))$$
$$= 5(100 - 18)$$
$$= 5(82)$$
$$= 410$$

(ii)

English Version

A geometric sequence is known to be $U_1 = 3, U_1 = 48$. Determine U_7.

Answer:

$$U_1 = a = 3$$
$$U_n = ar^{n-1}$$
$$U_5 = 3r^{5-1}$$
$$48 = 3r^4$$
$$r^4 = \frac{48}{3}$$
$$r^4 = 16$$
$$r = 2$$
$$U_7 = 3r^{7-1}$$
$$= 3r^6$$
$$= 3 \cdot 2^6$$
$$= 3 \cdot 64$$
$$= 192$$

**Figure 1. Student Answers to the Routin Problem**

Based on the observations of researchers, the mathematics learning process that took place so far did not improve students' mathematical thinking skills. In this case the teacher is more active in providing information or explaining the material, followed by writing formulas and giving example problems that are done with students with teacher dominance, then ending with giving exercises. In the learning process, the teacher only gives routine problems and solved based on examples given by the teacher. Students are only accustomed to doing exercises based on examples from the teacher, so they are less trained to think independently and creatively. Data from the initial test given to students on January 22, 2023.

Question:

1. Mr. Heru has IDR 1,000,000. he will distribute some of his money between his 6 children with the youngest child getting less than the oldest child. The first child gets IDR 200,000 and the 3rd child gets IDR 140,000. How much money does Mr. Heru have left after distributing it to his 6 children?

2. A farmer plants an apple tree in his garden. He planted the trees in a geometric row pattern. On the first tree, he harvested 10 apples. Each subsequent apple tree produces twice the number of apples the previous tree produced. He wants to know how many apples he can harvest in total after planting the 5th apple tree.

Answer:
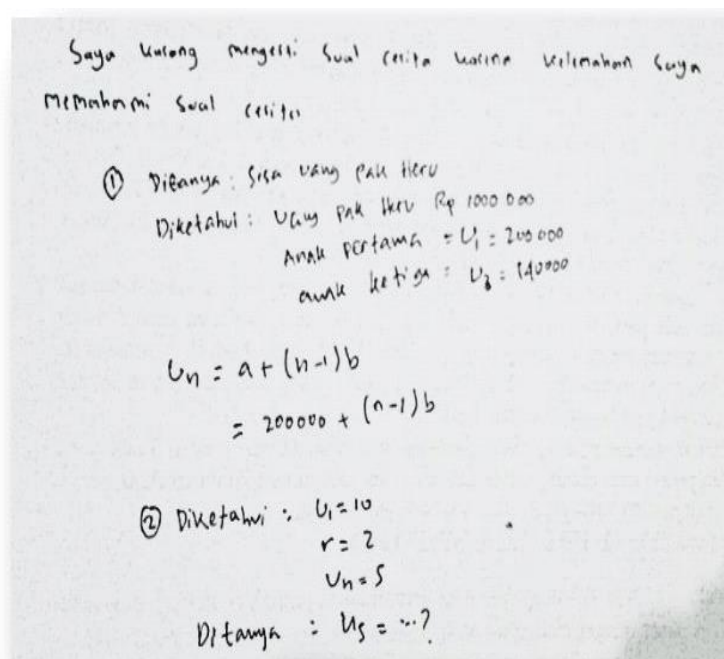
Indonesian Version:

English Version:

1. Asked:
   Remaining money Mr. Heru

   Is known:
   Mr. Heru's money: 1.000.000 IDR
   The first child: $U_1 = 200.000$
   The third child: $U_3 = 140.000$
   $$U_n = a + (n-1)b$$
   $$= 200000 + (n-1)b$$

2. Is known: $U_1 = 10$
   $$r = 2$$
   $$U_n = 5$$
   Asked: $U_5 = \cdots$

   Note:
   I don't understand the story because of my weakness in understanding the story

Indonesian Version:

English Version:

Is known: $U_1 = a = 5$
$b = 3$
Asked: $S_{10} = \cdots$
Formula:
$$S_n = \frac{n}{2}(2a + (n-1)b)$$
Answer:
$$S_{10} = \frac{10}{2}(2 \cdot 5 + (10-1)3)$$
$$= 5(10 + 9 \cdot 3)$$
$$= 5(10 + 27)$$
$$= 185$$
So, the result of
$$S_{10} = \frac{10}{2}(2 \cdot 5 + (10-1)3)$$
$$S_{10} = 185$$

Note:
I have a bit of difficulty in determining the formula for a problem and calculating the commas and determining what is known and asked.

Indonesian version:

English Version:

2. Is known: $U_1 = 10$
$$r = 2$$
$$U_n = 5$$
Asked:
$$S_5 = \cdots?$$
Answer:
$$S_n = \frac{a(r^n - 1)}{r - 1}$$
$$S_5 = \frac{10(2^5 - 1)}{2 - 1}$$
$$= \frac{10(10 - 1)}{1}$$
$$= 10 \cdot 9$$
$$= 90$$

1. Asked: Remaining money Mr. Heru
    Is known: Mr. Heru's money: 1.000.000 IDR
    The first child: $U_1 = 200.000$
    The third child: $U_3 = 140.000$
    Note:
    I am confused about what the formula is?

Figure 2. Results of Student Answers in the Initial Test of Solving Ability

Based on the results of the initial test, students did not understand the problem so as to produce the wrong answer and in the second problem students were unable to link the solution to the problem given. The results of the ability test conducted at SMAS Ibnu Siena Mulia Tasikmalaya show that the level of student ability seen from problem solving is very low.

The mathematical problem solving ability test was taken by 54 Ibnu Siena Mulia High School students in Tasikmalaya and Cikoneng. As a result, 96% of students were able to understand problems, 48% were able to plan strategies, 40% were able to solve problems, and 4% were able to review their work. Students' understanding of the problem is relatively good. This shows that students can understand the information given in the problem. However, students' ability to plan problem solving strategies, solve problems, and re-examine the results of their work still needs to be improved.

In general, the initial test results of mathematical problem solving ability of 54 students in class XI of SMA Ibnu Siena Mulia Tasikmalaya and SMA Ibnu Siena Mulia Cikoneng 49 students with a percentage of 91%. have low problem solving ability. This can be seen in the following table.

Table 1. Acquisition of Mathematical Problem Solving Ability Score and Percentage

Value	Qualification	Number of Students	Percentage
85-100	Very good	0	0%
70-84	Good	5	9%
55-69	moderate	3	6%
40-54	Less	40	74%
0-39	Very Less	6	11%

Source: Processed by the Author

Table 1 above shows that students' overall mathematical problem solving ability is below average. Only 9% of students scored good or above, while 74% of students scored poor or above. This shows that students' understanding of learning materials is still not optimal. Students still often experience difficulties in understanding mathematical concepts, applying mathematical skills, and solving mathematical problems so students need to be given more practice and guidance in solving mathematical problems.

Based on the results of interviews with several students in class XI of SMAS Ibnu Siena Mulia Tasikmalaya, it is known that learning mathematics in the class is less effective in improving students' ability to solve problems, especially on the subject of Sequence and Series. This is because the teacher only gives direct explanations and assignments whose solutions tend to follow the example problems given by the teacher. As a result, students become spoiled and reluctant to solve problems when faced with different

problems. In addition, students are also less able to understand the concepts of Sequence and Series, so they have difficulty in using the concepts and there are often mistakes in working on Sequence and Series problems. This causes student learning outcomes on the subject of Sequence and Series to be low. In addition, students also gave several reasons related to the solution of the problem given to students as follow.

Indonesia Version

English Version:

In this step, sometimes I forget the formula.

I can't remember math problem like I can remember formulas

In this step, sometimes I am a bit confused about calculations

Story questions like being confused about knowing and asking questions

Whwn it comes to stories, I am confused about how to count them and determine if they know and ask.
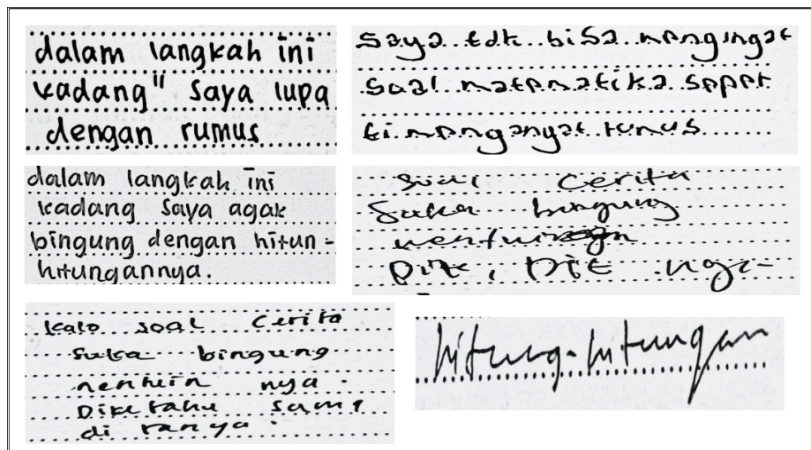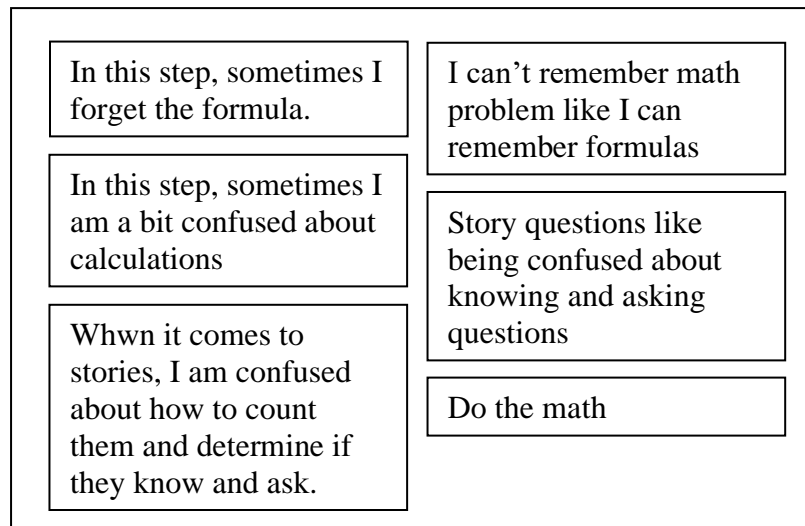
Do the math

Figure 3. Students' Reasoning When Working On Story Problems

The results of the questionnaire showed that there were indications that 45 students (83%) experienced difficulties in learning mathematics, especially in understanding sequence and series story problems. This shows that there is a significant gap between students' conceptual understanding abilities and mathematical problem solving abilities. This is reinforced by the research of Hardiyanti & Syaf (2022) who identified several specific difficulties faced by students in the topic of sequences and series, namely

determining the nth formula of an arithmetic and geometric series, understanding the concept of the first term, understanding story problems of sequences and series (Hardiyanti & Syaf, 2022)

Sequence and series topic has various methods of solving and in general, the problems presented are in the form of contextual problems so that it requires good mathematical problem solving skills to solve the problems presented (Pirmanto et al., 2020). In addition, this geometric Sequence and series problem can be applied to solve everyday problems, so it is very suitable to be used to determine students' problem solving skills (Rambe & Afri, 2020). One of the efforts to improve mathematical problem solving skills on the material of Sequence and series is to apply a learning model that makes the role of students more dominant and students work more with various knowledge so that students can understand the concepts given in their own way and understanding (Putri & Huda, 2022). Sequence and series topic is very suitable to be delivered through learning with a *project-based* learning model (Pamungkas et al., 2019).

Project-based learning model is one of the learning models that can improve students' mathematical problem solving skills (Nurfitriyanti, 2016; Yulianti, 2020). The application of the *project-based learning* model is able to actively involve students and contribute to the mathematics learning process in the classroom so that students' mathematical problem solving skills are improved and the learning process is more meaningful (Solong & Nasir, 2023). The *project-based learning* model focuses on solving real problems that occur in everyday life and developing work products or demonstrations, where students conduct studies or research (Faizah, 2020).

The results of preliminary observations through questionnaires, interviews and direct observations conducted on class XI students of SMAS Ibnu Siena Mulia Tasikmalaya obtained the fact that the teacher only uses the lecture method, giving exercise assignments question and answer, discussion in the process of learning mathematics. Students "only hear, record and memorize concepts so that students have difficulty in determining and solving problems related to the material of sequence and series. The lecture and question and answer learning model has weaknesses in terms of improving students' problem solving skills (Sembiring et al., 2015).

According to most students, the way math teachers teach during the class is by explaining the material in front of the class (85%) and recording material on the blackboard and doing exercise questions (67%). This is in accordance with the results of the teacher questionnaire that the learning method mostly used is lecture (100%) combined

with exercises and questions and answers. The dominant lecture method in math classes can cause students to be passive and less involved in the learning process. As a result, students cannot understand concepts deeply and cannot develop math skills. Teaching materials in the form of textbooks used contain procedural concepts along with examples of problems and exercise problems that are still routine in nature can also cause students to only understand concepts theoretically and cannot apply them in solving problems.

The teaching tools most often used when learning mathematics in grade XI are textbooks (96%). The teaching materials used at SMAS Ibnu Siena Mulia Tasikmalaya are Mandatory and Specialization Mathematics Books. Which is downloaded from the internet. In addition, teachers also use power point (50%) and LKPD (50%) in the teaching and learning process. The advantages of teaching materials used in mathematics classes are providing practice problems that cover various levels of difficulty (37%), providing clear and structured explanations of mathematical concepts (28%). While the shortcomings of the teaching materials used are that they do not encourage interaction or collaboration between students (41%) lack of use of visualization or concrete examples (35%), and do not utilize technology (19%) and do not include sufficient exercises to strengthen understanding and mathematical problem solving (6%). What needs to be improved or developed in the teaching materials is to provide more practice problems that hone "mathematical problem solving skills" and use learning models that are appropriate to the learning material. An example of a textbook excerpt from the Sequence and Series material used in schools is shown in figure 4 below.

1. **Barisan Aritmetika**

Barisan aritmetika adalah barisan bilangan yang selisih antara dua suku yang berurutan sama atau tetap.

Contoh :
   a) 3, 8, 13, 18, …. (selisih/beda = 8 – 3 = 13 – 8 = 18 – 13 = 5)
   b) 10, 7, 4, 1, …… (selisih/beda = 7 – 10 = 4 – 7 = 1 – 4 = – 3)
   c) 2, 4, 6, 8, …. (selisih/beda = 4 – 2 = 6 – 4 = 8 – 6 = 2)
   d) 25, 15, 5, –5, …. (selisih/beda = 15 – 25 = 5 – 15 = –5 – 5 = –10)

Selisih dua suku yang berurutan disebut **beda (b)**

Rumus :
$b = U_2 - U_1$
$b = U_3 - U_2 \rightarrow$ $b = U_n - U_{n-1}$
$b = U_4 - U_3$
dst

Jika suku pertama = a dan beda = b, maka secara umum barisan Aritmetika tersebut adalah:

U_1	U_2	U_3	U_4	U_n
a,	a + b,	a + 2b,	a + 3b, ………………………	a + (n-1)b

Jadi rumus suku ke-n barisan aritmetika adalah

$$U_n = a + (n - 1)b$$

Dengan : U_n = Suku ke-n
a = Suku pertama
b = beda atau selisih

English Version:

1. Arithmetic Sequences

An arithmetic sequence is a sequence of numbers where the difference between two consecutive terms is the same or constant.

Example:

a) 3, 8, 13, 18, ... (difference 8-3-13-8-18-13-5)
b) 10, 7, 4, 1, ... (difference 7-104-7-1-4--3)
c) 2, 4, 6, 8,.... (difference = 4-26-48-6=2)
d) 25, 15, 5, -5,.... (difference 15-255-15=-5-5=-10)

The difference between two consecutive terms is called the difference (b)

Formula:

$b = U_2 - U_1$
$b = U_3 - U_2 \rightarrow$ $b = U_n - U_{n-1}$
$b = U_4 - U_3$
etc

If the first terms are a and b, then in general the arithmetic sequence is:

U1	U2	U3	U4	U_n
a,	$a + b$,	$a + 2b$,	$a + 3b$, ...	$a + (n-1)b$

So the formula for the nth term of an arithmetic sequence is

$$U_n = a + (n-1)b$$

With:
U_n = nth term
a = First term
b = difference or difference

Indonesian version

Latihan Soal

Ayo berlatih.....

Untuk mengukur kemampuan kalian, kerjakan Latihan berikut

1. Dari barisan 3, 5, 7, 9, 11, ... suku ke 21 adalah
   A. 40   B. 43   C. 46   D. 49   E. 5

2. Suatu barisan aritmatika diketahui suku ke 4 adalah 6 dan bedanya 3. Suku ke 8 adalah ...
   A. 18   B. 31   C. 34   D. 37   E. 40

3. Suatu barisan aritmatika diketahui suku ke 15 adalah 30 dan bedanya –5. Suku ke 6 adalah
   A. 65   B. 25   C. 75   D. 80   E. 90

4. Rumus umum suku ke-n dari barisan 4, 9, 14, 19, 24, ... adalah ...
   A. 5n + 2   B. 5n – 1   C. 5n + 1   D. 5n – 2   E. 5n + 2

5. Suatu barisan aritmatika diketahui suku ke 6 adalah –4 dan suku ke 9 adalah –19, maka suku ke 11 adalah...
   A. –34   B. –29   C. –19   D. –24   E. –14

6. Hasil dari 5 + 7 + 9 + 11 + ... + 41 adalah ...
   A. 379   B. 437   C. 471   D. 407   E. 207

7. Jika 4 + 6 + 8 + 10 + ... + x = 130, maka nilai x adalah ...
   A. 10   B. 15   C. 18   D. 22   E. 32

8. Suku ke empat dari suatu barisan aritmatika adalah 20 dan jumlah 5 suku pertamanya sama dengan 80. Jumlah sebelas suku pertamanya adalah...
   A. 196   B. 210   C. 264   D. 308   E. 332

9. Dari suatu deret aritmatika diketahui jumlah n suku pertamanya ditentukan dengan rumus $S_n = \frac{n}{2}(3n + 5)$. Suku ke 6 adalah ...
   A. 19   B. 33   C. 36   D. 39   E. 42

10. Jumlah bilangan bulat antara 10 dan 60 yang habis dibagi 3 adalah
    A. 552   B. 486   C. 462   D. 312   E. 396

English Version:

Exercises

Let's practice.......

To measure your abilities, do the following exercise

1. From the sequence 3, 5, 7, 9, 11,... the 21st term is
   A. 40   B. 43   C. 46   D. 49   E. 5

2. In an arithmetic sequence it is known that the 4th term is 6 and the difference is 3. The 8th term is...
   A. 18   B. 31   C. 34   D. 37   E. 40

3. In an arithmetic sequence, the 15th term is 30 and the difference is -5. The 6th term is
   A. 65   B. 25   C. 75   D. 80   E. 90

4. The general formula for the nth term of the sequence 4, 9, 14, 19, 24, ... is ...
   A. 5n + 2   B. 5n-1   C. 5n+1   D. 5n-2   E. 5n + 2

5. In an arithmetic sequence it is known that the 6th term is –4 and the 9th term is –19, then the 11th term is...
   A. –34   B. –29   C. –19   D. –24   E. -14

6. The result of 5+7+9+11+ ... + 41 is ...
   A. 379   B. 437   C. 471   D. 407   E. 207

7. If 4+6+8+10+...+x= 130, then the value of x is ...
   A. 10   B. 15   C. 18   D. 22   E. 32

8. The fourth term of an arithmetic sequence is 20 and the sum of the first 5 terms is equal to 80. The sum of the first eleven terms is...
   A. 196   B. 210   C. 264   D. 308   E. 332

9. From an arithmetic series, it is known that the sum of the first n terms is determined be 12, with the formula $S_n = (3n + 5)$. The 6th term is. ...
   A. 19   B. 33   C. 36   D. 39   E. 42

10. The number of integers between 10 and 60 that is divisible by 3 is
   A. 552   B. 486   C. 462   D. 312   E. 396

Figure 4. Sequence and Series Topic In Textbooks

In Figure 4 the textbook used by students on Sequence and Sequence topic still has some shortcomings. The concepts of Sequence and Sequence presented in the textbook are still procedural, so students only understand these concepts theoretically. In addition, the sample problems and practice problems presented in the textbook are still routine, so they do not train students' mathematical problem solving skills.

Lack of time for math learning in the classroom is an obstacle to improving students abilities, especially in solving math problems. Teachers have to pursue a lot of material in a limited time, so the learning process is not optimal. To overcome these obstacles, teaching materials are needed that can be used independently by students. One type of teaching material that is appropriate is a module. Modules can provide material and

exercises systematically, so that students can learn independently and improve their math problem solving skills (Rahmawati & Apsari, 2019).

Module is a unit of learning material that can be studied by students independently (Kosasih, 2021). Modules are teaching materials that can be used independently by students. Modules contain clear components and instructions, so that students can follow them sequentially without teacher intervention. Modules are also packaged systematically and interestingly, with material coverage, methods, and evaluations that can help students achieve the expected competencies (Dirto, 2022). Modules play an important role in shaping students' scientific attitudes shown by students from an inquisitive attitude, respect for data / facts, critical thinking attitude, open-minded and cooperative attitude, and sensitive attitude to the surrounding environment and greatly affect the ability to solve problems (Ganefri et al., 2020; Zekri et al., 2020). This is in accordance with students' opinions about the desired teaching materials, namely images (37%), text-based (31%), sound and video (20%).

From the data above, it can be seen that the textbooks used so far do not support students' mathematical problem solving abilities. This is because textbooks only provide varied practice questions, so students are less enthusiastic and show low interest in participating in mathematics learning. So far, the teaching materials that have been made by teachers are LKPD, power points and handouts which are additional teaching materials for teachers. Through interviews, teachers hope that in the future there will be additional teaching materials that are more interesting to support mathematics learning in the classroom. According to the school profile, SMAS Ibnu Siena Tasikmalaya is a boarding school that does not encourage students to use communication devices such as cellphones and other electronic devices while in class, so that textbooks become the main reference in learning. However, the use of monotonous textbooks with exercises makes students feel bored in learning. Students want more interesting teaching materials. Teaching materials that are in accordance with the 2013 curriculum must be able to encourage students to think actively and creatively, and can measure student learning outcomes comprehensively. Teaching materials must also be able to assist teachers in delivering learning materials. Modules are one of the teaching materials that can meet these criteria. One of the teaching materials that can be a solution to the problems being experienced by class XI students of Ibn Siena Mulia Tasikmalaya High School is a module.

Based on the problems that have been described, it can be seen how important teaching materials are that support the improvement of students mathematical problem

solving abilities, so the researcher intends to develop a module that will use the Project Based Learning (PjBL) approach and will be applied to Sequences and Series topic for class XI students at Ibnu Siena Mulia High School. Tasikmalaya.

Some previous research on the development of Project Based Learning (PjBL) modules, including research conducted by Delyana et al (2021) said that statistics modules based on *project-based learning are* effective in improving students' statistical reasoning skills (Delyana et al., 2021). Hutapea & Manurung, said that project-based learning modules on set material are effective as teaching materials for seventh grade junior high school mathematics (Hutapea et al., 2022) . Sofiyana et al (2021) that project-based mathematics teaching materials can help improve *Higher Order Thinking Skill* (HOTS) and student character (Sofiyana et al., 2021). Winarlis & Hasanuddin (2019) that LKS based on *project-based learning "*class VIII junior high school students in Pekanbaru on the material of building cubes and beams has been valid, practical to use and effective to facilitate students' mathematical connection skills. Sofyan et al (2021) that flat-sided geometry student project worksheets can effectively improve students' mathematical problem solving skills (Sofyan et al., 2021). Kusumawati (2015) that the mathematics learning tool *project-based* learning model (*Project based learning*) on linear program material is effective for improving mathematical communication skills. Hikmiyah (2021) tates that the *Project-based* learning device assisted by minitab is effective for improving mathematical problem solving skills in class VIII junior high school students (Hikmiyah, 2021). Waya (2022) hat the mathematics learning module for the three-variable linear equation system is effective for improving mathematical problem solving skills (Waya, 2022). Sormin & Nurasahara (2019) stated that problem-based mathematics modules are effective for improving the mathematical problem solving skills of X grade students of SMA Negeri 4 Padangsidimpuan.

PjBL is an effective learning strategy for improving students' mathematical problem solving abilities and various other competencies. This approach encourages active student engagement, long-term learning, and a focus on real problems, resulting in significant benefits for students. PjBL emphasizes long-term learning processes, involves students directly with everyday life issues, and focuses on understanding and solving real, interdisciplinary problems (Mahtari et al., 2021; Wardani et al., 2021) . Meanwhile stated that Project Based Learning (PjBL) is a strategy that can improve various competencies such as academic achievement, level of thinking, critical thinking, problem solving abilities, creativity, independence, and presents the ability to see situations from a better perspective.

In addition, previous research conducted on the development of modules on the Sequence and Series topic includes research conducted by Khairunnisa & Ramlah (2021) that contextual-based modules are effective in helping students of class XI SMA Negeri 17 Merangin in the process of learning mathematics, especially in the material of Sequence and Series (Khairunnisa & Ramlah, 2021). Arianto, et al., (2023) states that contextual-based mathematics modules for class XI SMA are effective for solving math learning problems, especially in the Sequence and Series topic (Arianto et al., 2023). Wulandari & Qamar, states that the contextual-based Sequence and Series topic module for tourism program vocational students is effective in increasing student learning speed (*mastery learning*) (Wulandari & Qamar, 2018). Sili et al (2018) stated that the module of Sequence and Sequence material for class X SMK with the React Approach can improve the quality of mathematics learning (Sili et al., 2018). Aspriyani & Suzana (2020) stated that *brain-based learning-based* math modules using crossword puzzles are effective for geometric sequence and series material for SMA Negeri 3 Cilacap and SMA Ya Bakki Kesugihan students (Aspriyani & Suzana, 2020).

Based on the description above, several studies have been conducted Hafizah Delyana et al (2021), Megawati et al (2019), S Sofiyan et al (2019), Winarlis and Hasanuddin (2019), Sofyan et al (2021), Hikmiyah (2021), Waya (2022), Sormin et al (2019), developed *project-based learning* modules with material on statistics, sets, cubes, flat-sided spaces and linear programs. Their research has not discussed Sequence and Series topic. In addition, research conducted by Khairunnisa et al (2019), Panjanji et al (2023), Wulandari (2016), Sili (2018), Aspriyani et al (2020) developed a module of sequence and series using a contextual approach, react approach and *brain-based learning approach* but there is no research that develops *project-based learning-based modules* for sequence and series material.

Thus, based on the results of the literature review and preliminary studies conducted by researchers, it can be concluded that there is no *project-based learning* module that can improve students' mathematical problem solving skills on the sequence and series topic so that the purpose of this study aims to develop modules to improve students' mathematical problem solving skills on the material of sequence and series. Based on the results of the literature review and preliminary studies conducted by researchers, only a few studies have developed *project-based learning* modules for row and sequence materials. This can be due to several factors, such as the *project-based learning* model is a complex learning model and requires careful planning. In addition, the lack of knowledge and skills of

teachers in applying *project-based learning* models and limited resources, such as experts and infrastructure. Therefore, the development of learning modules based on *project-based learning* for the material of sequence and series still needs to be done to improve students' mathematical problem solving skills.

CONCLUSION

The mathematical problem solving ability of grade XI high school students on the material of sequence and series is still low. This is caused by learning that does not emphasize problem solving and does not involve students actively. In addition, the teaching materials used are not in accordance with the characteristics of students and teachers still lack skills in developing problem-solving-based learning. Based on the literature review and preliminary research conducted, there is no Project Based Learning (PBL) based learning module that can improve students' mathematical problem solving skills on the material of sequence and series. Therefore, this study aims to develop a Project Based Learning (PBL)-based learning module to improve the mathematical problem solving skills of grade XI high school students on the material of sequence and series.

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