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PRELIMINARY RESEARCH: DEVELOPMENT OF A TEACHING MODULE BASED ON PROBLEM BASED LEARNING TO IMPROVE STUDENTS' MATHEMATICAL LITERACY ABILITIES

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ABSTRACT

Mathematical literacy plays an important role in life. It can be used by humans in solving everyday life problems. However student's mathematical literacy ability are still very low. Therefore mathematics learning needs to be oriented to enhancing mathematical literacy ability. Mathematics learning will run smoothly if accompanied by good planning. This study aims to develop teaching module based on problem based learning. This research uses Research and Development method with the ADDIE (Analyze, Design, Develop, Implement, Evaluate) stages. In this preliminary research we carry out the analyze and design stages. At the analyze stage the data is processed using a qualitative descriptive approach and it is known that Three Variables Linear Equation System (TVLES) is difficult material for student. This is caused by limited teaching material and learning is not linked to contextual problems. Based on the results of the mathematical literacy test, it is known that student's mathematical literacy ability are very low, only 6% student are able to reach minimum criteria of 75. So this research can be continued by developing teaching modules based on problem based learning to enhance student's mathematical literacy ability.

Keywords: Mathematical Literacy, Teaching Modules, Student Worksheet, Problem Based Learning

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PRELIMINARY

Mathematical literacy is a person's ability to understand and utilize mathematics in finding solutions to various contextual problems in life (Amalia & Nuriadin 2023). Mathematical literacy is a person's ability to understand and utilize mathematics in finding solutions to various contextual problems in life (Danoebroto & Alviyah 2021). OECD (2019) defines mathematical literacy as personal ability to carry out mathematical reasoning which includes activities of formulating, using and interpreting mathematics to solve contextual problems in real life.

Mathematical literacy is a basic ability that has a big role in human life (Sumirattana, et al., 2017). This role is related to its usefulness in solving life's contextual

problems (Muzaki & Masjudin 2019). Someone who has adequate mathematical literacy ability is not only able to understand mathematics but can also use mathematics to find solutions to real problems in life (Masjaya & Wardono, 2018; Shafa & Yunianta, 2022). The competencies contained in mathematical literacy are identifying problems and formulating them, applying mathematical concepts to solve problems, and interpreting the results obtained from the solving process into a real context (Marsitin & Sesanti 2023).

The important role of mathematics is the basis that mathematics learning in schools must aim at developing students' abilities in mathematical literacy and increasing students' abilities in solving various contextual problems using mathematics (Sumirattana et al. 2017). This is in accordance with one of the learning principles in the Independent Curriculum that is currently in effect, namely literacy and numeracy-based learning.

The facts about the importance of mathematical literacy are not in accordance with the existing situation. The ability of Indonesian students in mathematical literacy is still very low (Rivai et al. 2023). They still experience difficulties in identifying problems, planning problem solving strategies, resolving problems with appropriate procedures, and checking the results of solving the problem (Purnama & Suparman 2020). The low mastery of Indonesian students in mathematical literacy can also be seen from the PISA test report data conducted by the OECD from 2003 to 2018 which shows the fact that the average score of Indonesian students in mathematical literacy is always less than the average score of mathematical literacy in all countries. who are participants in the PISA test (OECD 2019).

The factor that causes the low mastery of Indonesian students in mathematical literacy is the fact that mathematics learning in class only takes the form of knowledge distribution activities and does not optimize the exploration of students' mathematical literacy ability (Pamungkas & Franita, 2019). So far, mathematics learning has focused on memorizing mathematical formulas and is not related to students' real lives (Sumirattana et al. 2017). As a result, when students are given contextual mathematical problems they experience difficulties and cannot solve them correctly. Students at SMA Negeri 70 Jakarta also experienced the same thing. Based on observations and documentation studies carried out, students at SMAN 70 Jakarta experienced difficulties in solving contextual problems due to their inability to understand the meaning of the contextual problems given. As a result, they make mistakes when constructing mathematical models and solving them.

The factors that cause them to experience these difficulties are the fact that mathematics learning activities in class tend to be dominated by the teacher, students do

not participate actively and students are not accustomed to solving contextual problems. Teachers tend to teach mathematics by memorizing formulas and procedures for solving routine problems.

Based on this description, there is a need for innovation in mathematics learning so that students' abilities in mathematical literacy increase. This innovation involves changing the learning model which was previously conventional to learning that optimizes student activity and explores mathematical literacy ability. Teachers can use the Problem Based Learning (PBL) model because in PBL students participate actively in learning activities (Pamungkas & Franita 2019). Students start activities through contextual problems related to teaching material, then students understand and use these problems to hone their ability in solving problems (Andeswari, et al., 2022). PBL is designed based on open-ended contextual problems and motivates students to build understanding of mathematical concepts (Indah, et al., 2016).

Arends (2012) explains that in designing PBL there are five phases that must be carried out by teachers, namely: 1) orienting students to the problem, 2) organizing students to learn, 3) guiding both individual and group investigations, 4) developing and presenting the results of the work, 5) analyze and evaluate the results of problem solving. Therefore, PBL is appropriate for use in learning that is oriented towards improving students' mathematical literacy ability. In PBL, students build their knowledge and understanding of mathematical concepts through the contextual problems presented (Boye & Agyei 2023). Students identify information from contextual problems then explore it through group discussions to determine possible solutions and choose the best solution (Liu & Pásztor, 2022).

Learning using PBL will be implemented effectively if it is preceded by good planning. This planning takes the form of preparing PBL-based teaching modules. In the Independent Curriculum, teaching modules are defined as tools that contain learning objectives, learning activities, learning media, assessments, and learning resources used in one learning material (Anggraena et al. 2017). One of the learning media that must be included in the teaching module is the Student Worksheet (LKPD). LKPD contains material and activities carried out by students during the learning process. This LKPD is an inseparable part of the Independent Curriculum teaching module.

In Wardono et al (2016) research, Indah et al (2016), Pamungkas & Franita (2019), and Hasanah et al (2022) explained that mathematics learning carried out using the problem based learning model has proven to be effective in improving students'

mathematical literacy ability. Lestari et al (2023), Putri et al (2020), and Hilaliyah et al (2019) in its development research, it produced a PBL-based mathematics module product which was proven to facilitate increasing mathematical literacy ability. Therefore, in this research a teaching module product was developed using the PBL model which can facilitate increasing students' mathematical literacy ability.

METHODS

This research is Research and Development research with ADDIE stages (Analyze, Design, Develop, Implement, and Evaluate). In this research, researchers carried out the Analyze and Design stages which are part of the ADDIE stage. The Analyze stage is carried out by carrying out a preliminary analysis to determine the gap between the ideal situation and the situation that occurs in the field. The Design stage is carried out by designing PBL-based teaching modules to solve problems that occur in the field.

The Analyze stage is carried out by distributing questionnaires, observing teaching and learning activities, studying documentation on learning tools, and administering mathematical literacy tests. Questionnaires were given to 33 class XI students and 6 Mathematics teachers at SMAN 70 Jakarta. The mathematical literacy test was given to 33 class XI students by providing test questions in the form of contextual problem descriptions on the topic Systems of Linear Equations with Three Variables (SPLTV). The sample was taken using a random sampling technique for class XI students who had studied all learning topics in class X. The data was processed using a qualitative descriptive approach and analyzed using the Miles and Huberman technique, namely reducing data, presenting data and drawing conclusions. The Design stage is carried out by designing teaching modules using the PBL model.

RESULT AND DISCUSSION

The research was carried out at SMA Negeri 70 Jakarta in February 2023. The first stage was to distribute questionnaires to 33 students in class XI-G with the aim of analyzing the students' needs. Next, a questionnaire was distributed to 6 Mathematics teachers at SMA Negeri 70 Jakarta with the aim of analyzing teacher needs. The questionnaire instrument for students is in the form of semi-closed questions, questions are given by providing alternative answer choices and space is provided for students to write other answers according to the conditions experienced. These questions contain students' opinions regarding material that is considered difficult, the causes of learning difficulties,

the need for teaching materials, and the importance of learning mathematics which is linked to contextual problems.

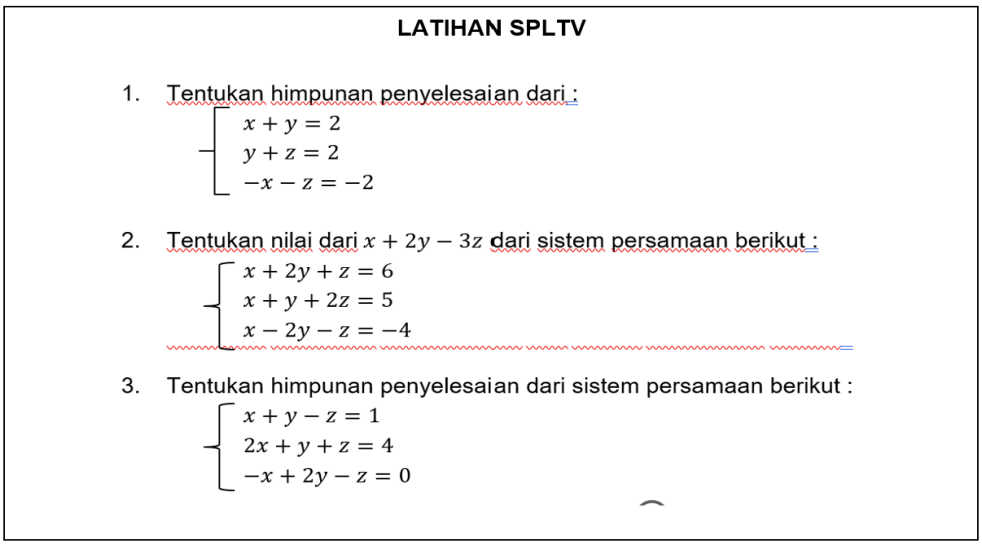
Based on the results of the student needs analysis questionnaire, it was found that 91% of students found it difficult on the topic Three Variable Linear Equation Systems (SPLTV). These difficulties are caused by the limited teaching materials used, the example questions presented are easy and do not match the questions in the assessment, and the material discussed does not use stimulus problems in real life. 94% of students stated that they needed teaching materials that could be used for learning. 91% of students also stated that they agreed if teaching materials were made in the form of Student Worksheets (LKPD). They hope that the LKPD is easy to learn, uses contextual problems in life so that it can arouse curiosity and students feel the benefits of studying the material. LKPD is also accompanied by practice questions and discussions that support the achievement of learning objectives and are in accordance with the assessment given by the teacher.

Based on the results of the teacher needs analysis questionnaire, it is known that the reason students experience difficulties in SPLTV material is that so far learning has been carried out with the aim of being able to count numbers and is rarely linked to contextual problems. Pamungkas & Franita (2019) states that the cause of low mathematical literacy ability is the fact that mathematics learning in class only takes the form of knowledge distribution activities and does not optimize the exploration of students' mathematical literacy ability. So far, mathematics learning has focused on memorizing mathematical formulas and is not related to students' real lives (Sumirattana et al. 2017). As a result, students are not used to dealing with problems presented with long narratives. They have difficulty understanding and make mistakes in constructing mathematical models.

Teachers also stated that so far they have prepared their own teaching modules as a guide in teaching and learning activities, but these teaching modules are still rarely linked to contextual problems. The teaching module contains routine material and questions. Teachers hope that there will be teaching modules equipped with LKPD that contain contextual problems in life so that they can improve students' abilities to solve various contextual problems.

Through observing learning activities, it is known that teachers apply conventional methods, namely learning is dominated by the teacher and does not activate students. Learning is carried out by prioritizing students' ability to calculate and rarely uses contextual problems as learning material. The teacher has also used teaching materials in the form of LKPD, but the LKPD only contains techniques for solving SPLTV and

examples of routine questions, namely determining variable values in SPLTV. The material in the LKPD is not linked to contextual problems in life.



LATIHAN SPLTV

1. Tentukan himpunan penyelesaian dari :

$$\begin{cases} x + y = 2 \\ y + z = 2 \\ -x - z = -2 \end{cases}$$

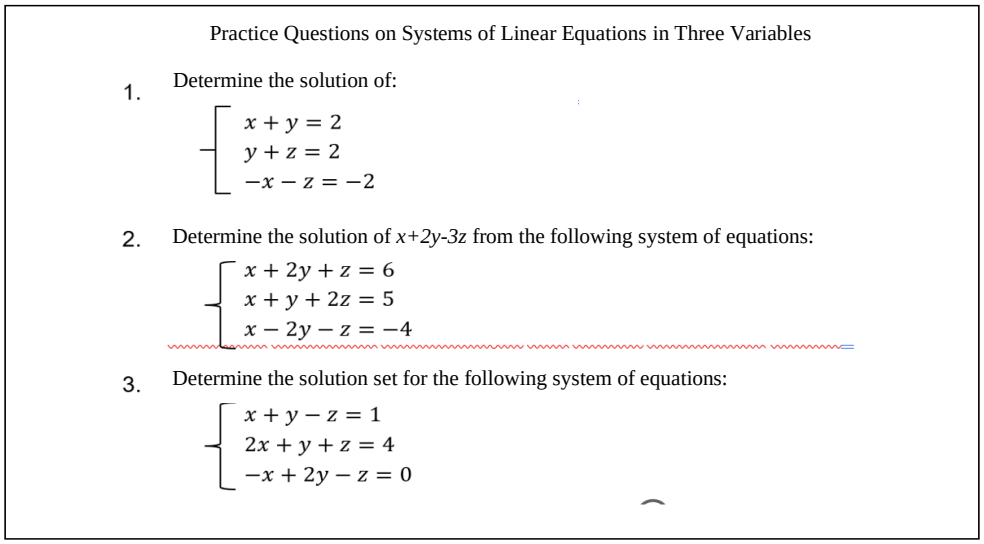
2. Tentukan nilai dari $x + 2y - 3z$ dari sistem persamaan berikut :

$$\begin{cases} x + 2y + z = 6 \\ x + y + 2z = 5 \\ x - 2y - z = -4 \end{cases}$$

3. Tentukan himpunan penyelesaian dari sistem persamaan berikut :

$$\begin{cases} x + y - z = 1 \\ 2x + y + z = 4 \\ -x + 2y - z = 0 \end{cases}$$

English Version



Practice Questions on Systems of Linear Equations in Three Variables

1. Determine the solution of:

$$\begin{cases} x + y = 2 \\ y + z = 2 \\ -x - z = -2 \end{cases}$$

2. Determine the solution of $x+2y-3z$ from the following system of equations:

$$\begin{cases} x + 2y + z = 6 \\ x + y + 2z = 5 \\ x - 2y - z = -4 \end{cases}$$

3. Determine the solution set for the following system of equations:

$$\begin{cases} x + y - z = 1 \\ 2x + y + z = 4 \\ -x + 2y - z = 0 \end{cases}$$

Figure 1. Example of a Teacher's LKPD Containing Routine Questions

Furthermore, a documentation study was carried out on the teaching tools owned by the teacher and it was discovered that the learning objective in the SPLTV material was that students were able to identify real problems in life related to SPLTV and were skilled at determining solutions to SPLTV creatively. Based on this learning objective, learning activities must be linked to contextual problems and oriented towards increasing mathematical literacy ability. Learning that utilizes contextual problems as a stimulus is called the Problem Based Learning (PBL) model. In PBL, students learn to solve contextual problems and use it as a medium for learning mathematical concepts and

procedures. Wardono et al (2018) in his research stated that the use of the PBL model in learning can improve students' abilities in mathematical literacy.

Next, a mathematical literacy test was carried out on the SPLTV material to obtain information about the abilities of students at SMA Negeri 70 Jakarta in mathematical literacy. The test was given in the form of essay questions to 33 students in class XI-G. The indicators of mathematical literacy ability used are: 1) being able to understand problems which is characterized by being able to write down known information and the problems being asked based on the contextual problems presented., 2) being able to formulate mathematical models of contextual problems., 3) being able to use concepts and procedures. mathematics to complete mathematical models., 4) able to interpret the results obtained into a real context and evaluate them.

Based on the mathematical literacy test on the SPLTV material, the results showed that only 6% of students were able to achieve a score above the minimum criteria set by the school, namely 75. The details of students' achievements in each indicator of mathematical literacy ability are described in the following table.

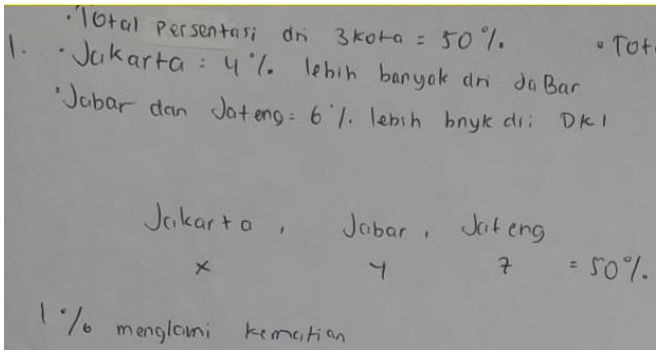
Table 1. Percentage of Students in Each Indicator Mathematical Literacy Ability

Number	Indicators of Mathematical Literacy Ability	% Learners	Category
1	Able to understand problems that are characterized by being able to write down known information and problems asked based on the contextual problems presented	3%	Very low
2	Able to formulate mathematical models of contextual problems	27%	Low
3	Able to use mathematical concepts and procedures to complete mathematical models	6%	Very low
4	Able to interpret the results obtained into a real context and evaluate them	6%	Very low

Furthermore, students' achievements in each indicator of mathematical literacy ability are described as follows:

1. First indicator: being able to understand the problem which is characterized by being able to write down the information known and the problem being asked based on the contextual problem presented.

   Based on the information in table 1, it is known that only 3% of students are able to understand the problem correctly.

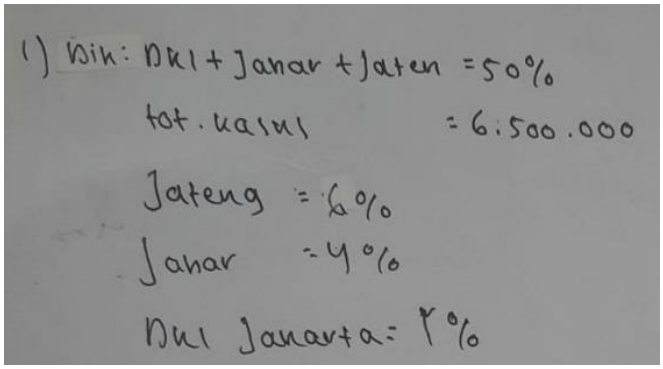


English Version

1. Total percentage from 3 cities=50%
   Jakarta is 4% more than West Java
   West Java and Central Java are 6% more than Jakarta
   Jakarta, West Java, Central Java
   x 4 7 =50%
   1% death

Figure 2. Students Who Answered Correctly In Indicator 1

In Figure 2, students are able to write down the information they know and write down the problems asked based on contextual problems.



English Version

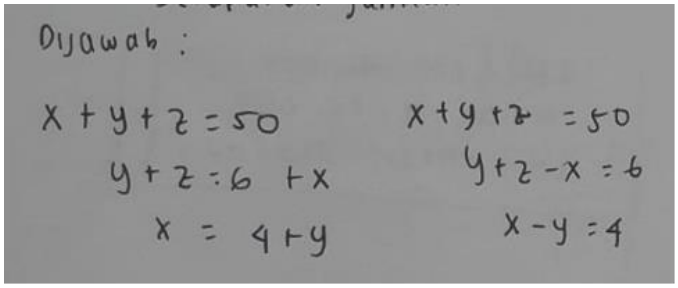
2. Known: Jakarta+West Java+Central Java=50%
   total cases=6,500,000
   Central Java=6%
   West Java=4%
   Jakarta=1%

Figure 3. Students Who Answered Incorrectly In Indicator 1

In Figure 3, students make mistakes when writing down information known about the problem. The student wrote that the percentage of cases in Central Java was 6%, while the contextual problem said that the total percentage in West Java and Central Java was 6% more than the percentage in DKI Jakarta. The student also

wrote that the percentage of cases in West Java was 4%, while the contextual problem said that the percentage of cases in DKI Jakarta was 4% more than West Java. Furthermore, the student also wrote that the percentage in DKI Jakarta was 1%, while the contextual problem said that 1% of the total cases in DKI Jakarta experienced death. Thus, these students do not understand the contextual problems presented.

2. Second indicator: able to formulate mathematical models of contextual problems. Based on the information in table 1, it is known that only 27% of students were able to formulate mathematical models correctly from the contextual problems presented.



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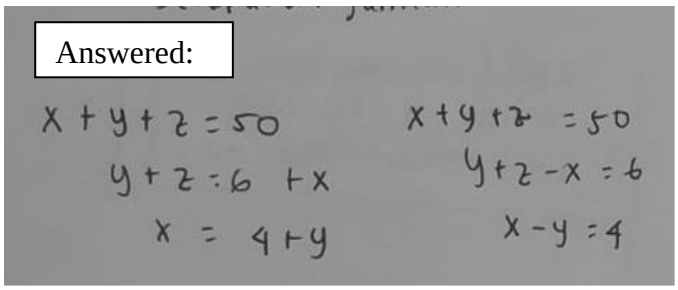
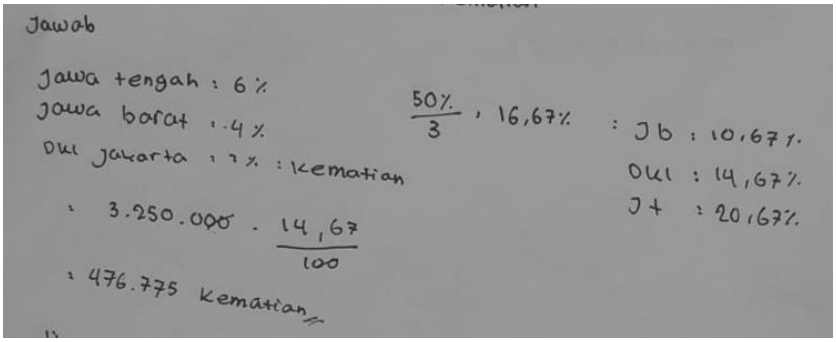


Figure 4. Students who answered correctly in Indicator 2

In Figure 4, students are able to formulate mathematical models accurately based on information on the contextual problems presented.



English Version

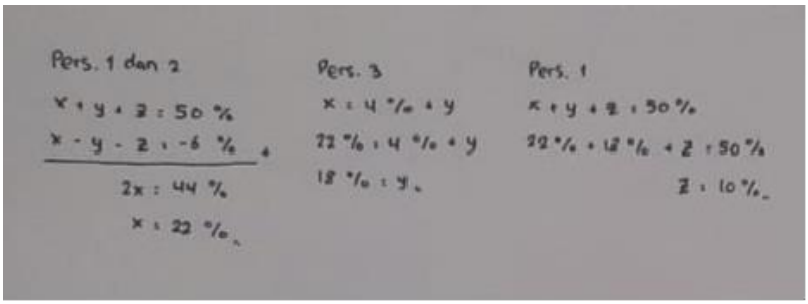
3. Answer:
   Central Java=6% (50%/3)=16,67% : West Java=10,67%
   West Java=4% Jakarta=14,67%
   Jakarta=1% death Central Java=20,67%
   =3,250,000x(14,67/100)
   =476,775 death

Figure 5. Disabled Students in Indicator 2

In Figure 5, students do not write down the mathematical model of the contextual problem given. This is because students do not understand the meaning of the problem and cannot determine the variables in the problem. We conclude that these students have not been able to formulate mathematical models correctly.

3. Third indicator: able to apply mathematical concepts and procedures to find solutions to mathematical models.

   Based on the information in table 1, it is known that only 6% of students are able to apply mathematical concepts and procedures to find solutions to the mathematical models that have been prepared.



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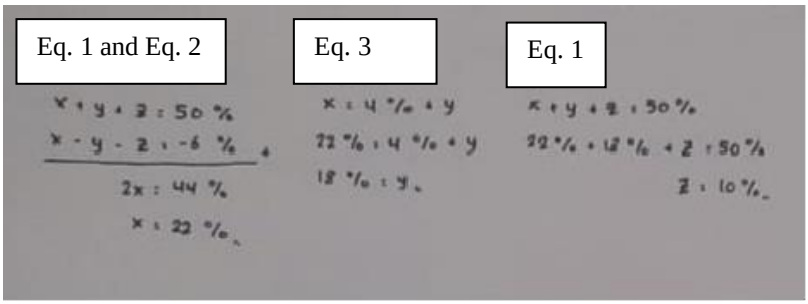
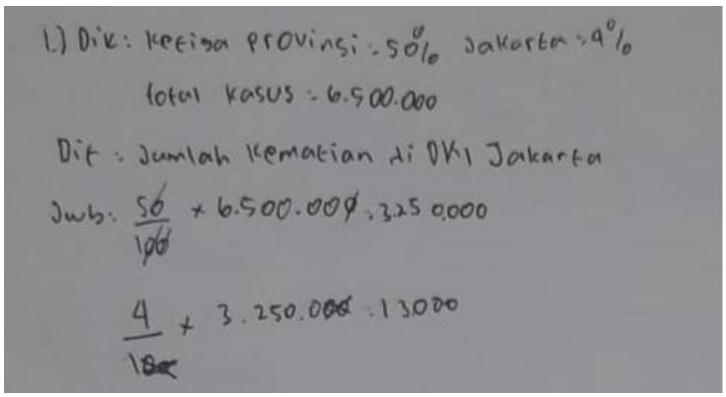


Figure 6. Students who are able to answer correctly in indicator 3

In Figure 6 it is known that these students are able to apply SPLTV concepts and procedures in determining variable values. Students apply elimination and substitution techniques correctly in determining variable values.



English Version

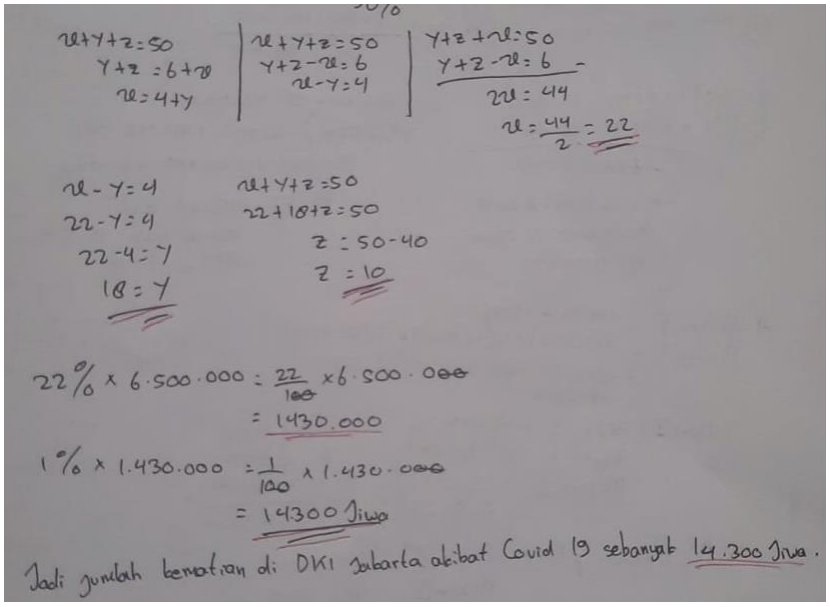
1. Known: Three provinces=50%, Jakarta=4%
   Total Cases=6,500,000
   Asked: Number of deaths in Jakarta?
   Answer:
   (50/100)x6,500,000=3,350,000
   (4/100)x3,250,000=13,000

Figure 7. Disabled Students in Indicator 3

In Figure 7, students are unable to write down problem solving procedures using SPLTV. Students do not understand the meaning of the problem and make mistakes when writing down the information they know.

4. Fourth indicator: able to interpret settlement results into a real context and evaluate them.

   Based on the information in table 1, it is known that only 6% of students are able to interpret the solution results into a real context and evaluate them.



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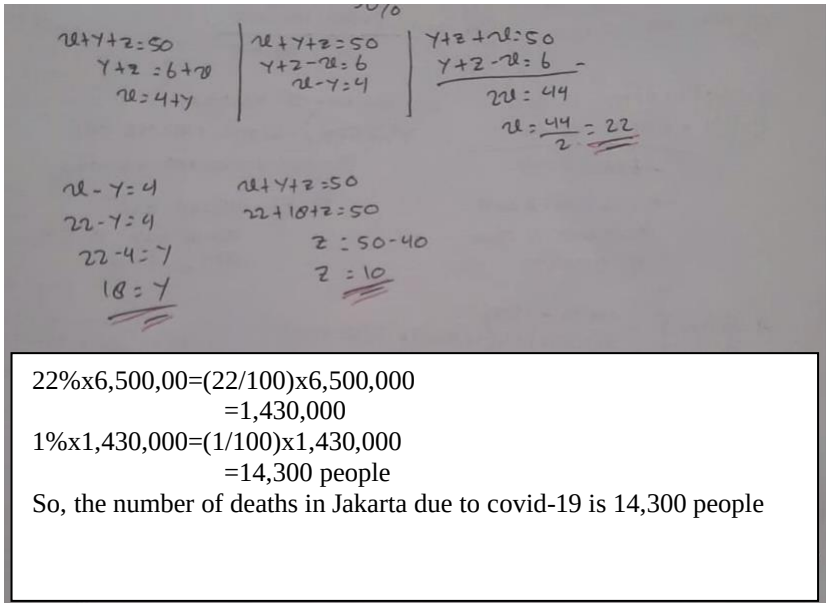
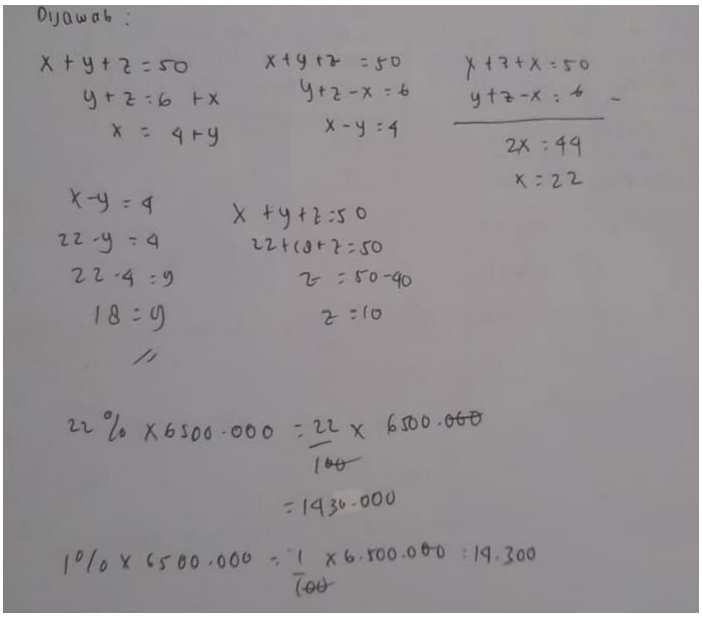


Figure 8. Capable Students in Indicator 4

In Figure 8, it is known that after students can determine the values of the variables x, y, and z, they are then able to interpret the values of these variables into a real context and answer the problems asked.



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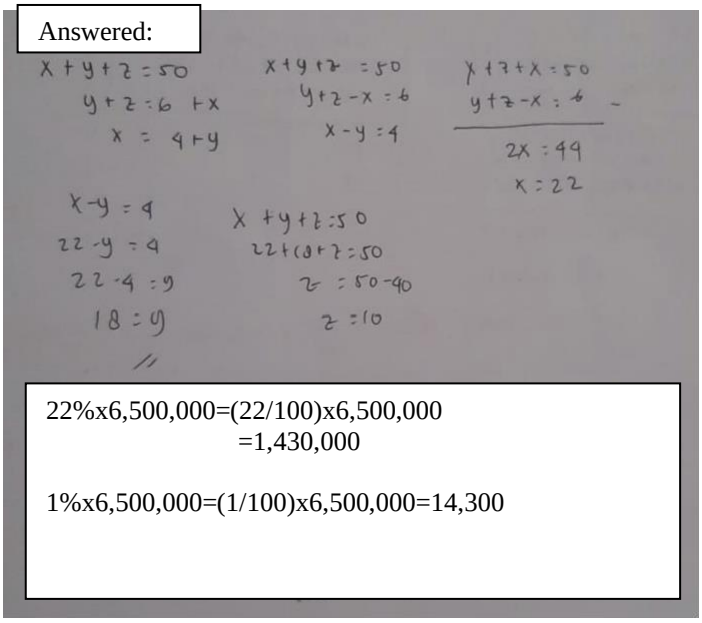


Figure 9. Disabled Students in Indicator 4

In Figure 9, it is known that students can determine the values of the variables x, y, and z but are unable to interpret the results of the solution in a real context or draw conclusions from the problem being asked.

Based on this analysis, we get information that students at SMA Negeri 70 Jakarta have very low mathematical literacy ability. Mistakes occur starting from students not

understanding the contextual problems presented so that students experience difficulty in compiling mathematical models. Errors in compiling this mathematical model of course result in errors in determining the solution procedure. This was expressed by the teacher that so far students have not been familiarized with contextual problems so they have difficulty understanding the problems. Therefore, it is necessary to design a teaching module using PBL that can provide solutions to the problems that occur.

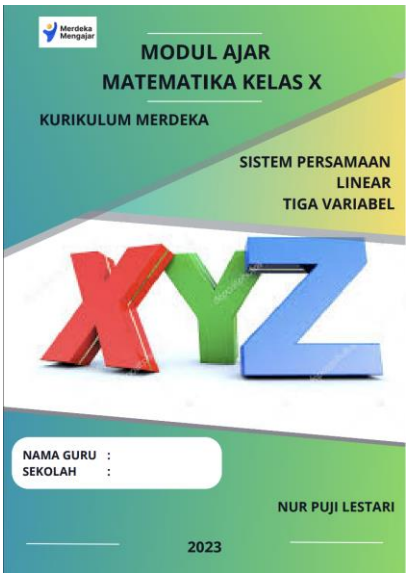
Tahap berikutnya pada penelitian ini adalah tahap *Design* yaitu merancang modul ajar Kurikulum Merdeka menggunakan PBL pada materi SPLTV yang dapat memfasilitasi peningkatan kemampuan peserta didik dalam literasi matematika. Tahap *design* diawali dengan mempelajari tujuan pembelajaran yang ditetapkan pada materi SPLTV yaitu peserta didik dapat menyelesaikan masalah kontekstual yang berkaitan dengan sistem persamaan linear tiga variabel. Berdasarkan tujuan pembelajaran ini maka modul ajar tersebut harus memuat rancangan kegiatan pembelajaran yang menyajikan berbagai masalah kontekstual pada topik SPLTV. Modul ajar tersebut juga harus dilengkapi dengan LKPD yang berisi kegiatan-kegiatan yang lebih banyak melibatkan peserta didik secara aktif. Tahap desain modul ajar ini meliputi : 1) *cover* modul ajar; 2) halaman informasi umum modul ajar; 3) halaman komponen inti modul ajar; 4) halaman lampiran modul ajar. Tahap desain LKPD meliputi : 1) *cover* LKPD; 2) halaman informasi umum LKPD; 3) halaman kegiatan pembelajaran; 4) halaman penilaian diri.

The next stage in this research is the Design stage, namely designing the Independent Curriculum teaching module using PBL on SPLTV material which can facilitate increasing students' abilities in mathematical literacy. The design stage begins with studying the learning objectives set out in the SPLTV material, namely that students can solve contextual problems related to systems of linear equations with three variables. Based on this learning objective, the teaching module must contain a design of learning activities that presents various contextual problems on the SPLTV topic. The teaching module must also be equipped with LKPD which contains activities that involve students more actively. The teaching module design stage includes: 1) teaching module cover; 2) teaching module general information page; 3) teaching module core components page; 4) teaching module attachment page. The LKPD design stage includes: 1) LKPD cover; 2) LKPD general information page; 3) learning activities page; 4) self-assessment page.

Teaching Module Design

1. *Cover* of Teaching Module

   The cover of the teaching module contains the title, material and author's identity. The cover design is presented in the following figure:



English Version

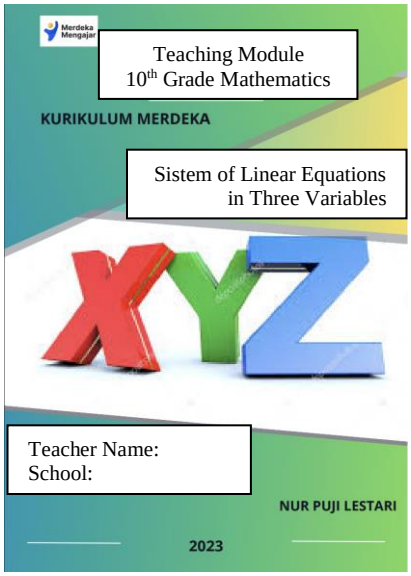


Figure 10. Teaching Module Cover Design

2. General Information Page

   The general information page contains module identity, initial competencies, Pancasila student profile, facilities and infrastructure, target students, and learning models.

3. Core Components Page

The Core Components page contains learning outcomes, learning objectives, indicators of learning objectives, meaningful understanding, trigger questions, learning activities, assessments, enrichment and remedial, as well as reflections of educators and students.

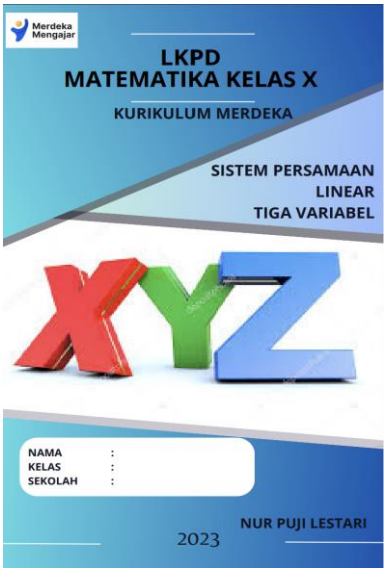
4. Attachment Page

The attached page contains LKPD, enrichment and remedial programs, reading materials for educators and students, glossary and bibliography.

Desain LKPD

1. LKPD Design

The LKPD cover contains the title, material and author's identity. The cover design is presented in the following figure:



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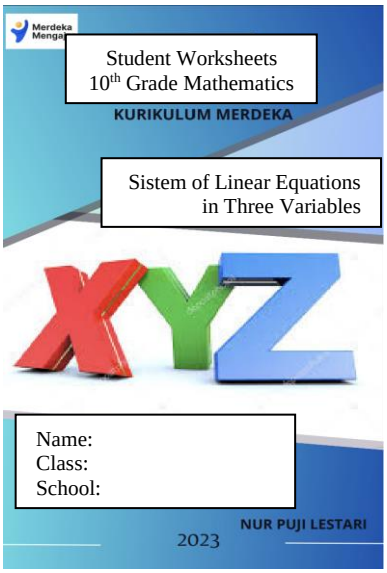

Figure 11. LKPD Cover Design

2. General Information Page

   The General Information page contains the identity of the LKPD, learning achievements, learning objectives, learning objective indicators, initial competencies, Pancasila student profiles, and concept maps.

3. Learning Activities Page

   The Learning Activities page contains contextual problems and activities carried out by students during learning.

CONCLUSION

This research produces conclusions, namely: 1) Students at SMA Negeri 70 Jakarta experience difficulties with SPLTV material. These difficulties are caused by the limited teaching materials used, the example questions presented are easy and do not match the questions in the assessment, and the material discussed is not linked to real life problems. 2) The mathematical literacy ability of students at SMA Negeri 70 Jakarta on SPLTV material are very low. Only 6% of students were able to achieve a score above the minimum criteria set by the school, namely 75. Thus, research can be continued by developing teaching modules based on problem based learning to improve students' mathematical literacy ability.

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