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Development of Problem Based Differentiated Learning Comparison Materials in Junior High School

Dyna Meriza, Cecil Hiltrimartin*, Yusuf Hartono

Department of Mathematics Education, Sriwijaya University, Palembang, Indonesia
*Email: cecilhiltrimartin@fkip.unsri.ac.id

Abstract

The importance of differentiated learning in the classroom is to meet students' diverse learning needs, increase engagement, and maximize individual potential so that each student can achieve optimal learning outcomes. This research was carried out as a starting point in the use of differentiated learning modules on problem-based comparison materials so that students' mathematical problem-solving skills are good, but there are still many learnings that do not integrate student needs, and students still experience difficulties in understanding comparative materials. The type of research used is development studies-type design research with the aim of producing a problem-based differentiated learning module on comparative materials that is valid, practical, and has a potential effect of using differentiated learning modules of comparative materials on students' mathematical problem-solving skills. The research subjects were 36 students of class VII.8 of junior high school 17 Palembang. The data collection techniques used were questionnaires, tests, and interviews. The results showed that the problem-based differentiated learning module on comparison material was quite valid with an average percentage of 82.9% and very practical with an average percentage of 83.3%, and students had good mathematical problem-solving skills with an average percentage of 83.069% after the implementation of learning. The resulting teaching module contains lesson plans, student worksheets, teaching materials, assessments, and assessment rubrics.

Keywords: Comparison; Differentiated Learning; Independent Curriculum; Problem Solving; Teaching Modules

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INTRODUCTION

Learning is essential in the face of ever-changing times (Kemendikbudristek, 2022). Learning should be able to adapt to developments in the era and accommodate students' needs (Ciobanu et al., 2023). Implementing differentiated learning is a suitable strategy for fostering an inclusive environment where all students feel valued and supported in their pursuit of optimal learning outcomes (Herwina, 2021). The adaptations include students' different interests, learning profiles, and learning readiness. Through differentiated learning, students will perform better because the tasks given by the teacher match their pre-existing skills and understanding, stimulate their curiosity and provide opportunities for them to work in their preferred way (Naibaho, 2023). If the teacher already knows and identifies the student's potential, the teacher can determine the learning that matches the student's potential (Mulyawati et al., 2022).

Differentiated learning is in line with the Merdeka Curriculum or other name Independent Curriculum. The main characteristics of differentiated learning are an environment that encourages students to learn, a curriculum with clear learning objectives, continuous assessment, effective classroom management, and attention to student needs (Gheyssens et al., 2023; Jayanti et al., 2023). Differentiated learning involves a range of teacher-created activities where learning is prioritized and

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focused on the learning needs of the students (Fitra, 2022). Students' learning activities can affect their learning outcomes (Goss, 2022). It is important for teachers to continue to strive to create optimal learning activities so that learning outcomes reflect a deep level of understanding and good application of skills. Learning activities should also be problem-based because they can actively involve students and improve their mathematical problem-solving skills (Sari & Hapizah, 2020). For this reason, teachers need to design or compile teaching modules that pay attention to student characteristics and are problem-based, allowing student learning outcomes to be maximized (Chen et al., 2016). The results of the design are subjected to a problem-based differentiated teaching module, which is employed as an alternative in the teaching and learning process (Marlina et al., 2023). Teaching modules play an important role in helping teachers design learning (Salsabilla et al., 2023).

However, many teachers have not mastered the technique of compiling and developing teaching modules in the Merdeka curriculum, although ideally, it is vital for teachers to compile teaching modules to the fullest (Maulida, 2022). The implementation of differentiated learning, especially in mathematics, is still limited (Gusteti & Neviyarni, 2022). Teachers only look for easy ways to teach, not using modules or other learning resources other than government textbooks (Sari & Hapizah, 2020). The process of acquiring knowledge that does not use teaching modules properly can make the learning that is done seem less exciting and the delivery of content is not systematic, so that learning is not optimal (Salsabilla et al., 2023).

Equivalent and inverse comparison is one of the materials studied in Grade VII and included in relevant learning outcomes. It is of great importance to gain an understanding of comparison material, as it is a key component in many aspects of our daily lives (Agnesti & Amelia, 2020). Comparative materials usually contain story problems, which are solved using Polya's four stages, namely analyzing the problem, applying the formula, solving the problem, and checking the results (Azhar et al., 2021) to develop numeracy and reasoning skills, as well as critical, logical, creative and careful thinking (Hiltrimartin & Pratiwi, 2019).

Although the concept of comparison is very close to everyday life, quite a few students still experience difficulties and errors when working on comparison story problems, due to a lack of skills in understanding the given text and difficulties in starting the thinking process in solving problems (Azhar et al., 2021). Another factor is students' lack of seriousness and interest in learning comparison material and students' inability to translate story problems (Mulyani, 2020). It is often a challenge to learn comparison material because of students' low memory and lack of motivation to learn the material more deeply as well as difficulties in understanding the concept (Panjaitan et al., 2022).

Difficulty in understanding comparison material can have an impact on students' mathematical problem-solving skills in general (Latifah & Afriansyah, 2021). Therefore, an innovative and effective learning approach to teaching comparison material is needed to increase students' understanding and interest in learning (Ummah, 2021). It is crucial for a teacher to be able to design and implement learning according to student characteristics (Kemendikbudristek, 2022). The observations made by

Marnila (2019), that in conventional classrooms, students' differences are seen as a problem, students' interests and learning profiles are rarely taken into account, assessments are made at the end of learning to find out who has mastered the material, which teacher has solved the problem, etc. In differentiated learning teachers provide opportunities for pupils to develop their potential and achieve maximum learning outcomes (Gheyssens et al., 2023). Whereas in differentiated learning teachers freely provide opportunities for pupils to develop their potential to achieve maximum learning outcomes. In addition, ideally, mathematics learning allows students to gain learning experiences to be able to construct their own knowledge. In line with this, teachers prefer to deliver monotonous learning (Afifah et al., 2023). Even though they are faced with various different student characteristics, so that differentiated learning, especially problem-based learning, is rarely applied in the classroom.

Problem-based teaching modules have been shown to be effective in improving students' problem-solving skills and understanding of mathematical concepts (Martaningsih et al., 2022). The issues presented can be linked to everyday occurrences, thereby encouraging students to engage with them and seek solutions (Setyadi & Saefudin, 2019). Based on the literature review Gusteti & Neviyarni (2022) stated differentiated learning is more interesting and can improve students' learning outcomes. In addition, similar research has been conducted by Setyadi & Saefudin (2019) research was not integrated with differentiated learning in developing a valid, practical and effective problem-based learning module for VII grade students of junior high school 17 Palembang.

Based on previous research and development, the novelty of this research is the integration of the research conducted with differentiated learning strategies that adapt to the characteristics of junior high school students, as well as the use of interesting and authentic problems in learning so that students can be actively and meaningfully involved in the learning process. This study aims to produce a valid and practical problem-based differentiated learning module for comparison materials and determine its potential effects on students' mathematical problem-solving skills.

METHODS

The research method employed was that of design research, with the study subjects comprising class VII students of junior high school Negeri 17 Palembang during the odd semester of the 2023/2024 academic year. The objective of this research is to develop a valid and practical problem-based differentiated learning module on comparison material in junior high school, and the objective of this study is to ascertain the potential impact of differentiated learning modules on students' mathematical problem-solving abilities. The teaching module had been developed by considering the needs and learning styles of the students and incorporating problem-solving skills.

The research method employed in this study comprises two stages. The preliminary stage encompasses the preparation stage, analysis stage, design stage and formative evaluation consisting of self-evaluation, expert review, one to one, small group, and field test (Tessmer, 1993). The following

is the procedure used in this research in developing teaching modules presented in the form of a flow chart in Figure 1.

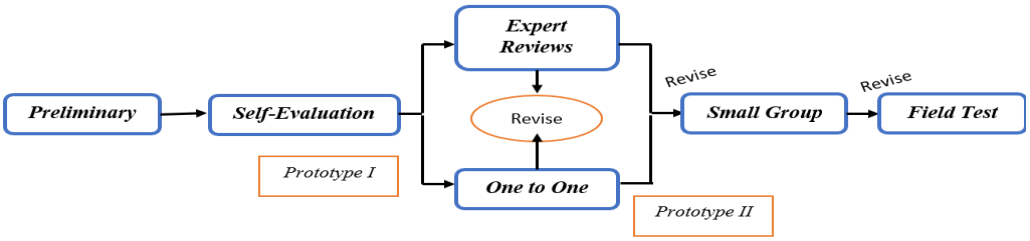


Figure 1. Research flow chart

In Figure 1**,** there is a research flow in developing teaching modules from the preliminary stage to the final module. The methodology used for data collection was a questionnaire, tests, and interviews. The questionnaire used consists of two types of questionnaires, namely a validity questionnaire and a practicality questionnaire. The validity questionnaire was given to 3 experts at the expert review stage which aims to measure the validity of the module that has been developed. The practicality questionnaire was given after the product was tested on 6 students at the small group stage which aims to determine student responses. The test questions were given at the final meeting field test stage with three problem solving questions to determine the appearance of quantifiable indicators of students' mathematical problem-solving abilities. Interviews were conducted with three students at the field test stage, and they were used as supporting data or further information regarding the results of student test answers. This study used mathematical problem-solving ability which consisted of four indicators. Table 1 presents the indicators and descriptors of students' mathematical problem-solving abilities**.**

Table 1. Indicators and descriptors used to assess students' mathematical problem-solving skills

Indicator	Descriptor
Understanding the problem	Understand and write the information known and asked in the problem
Developing a plan	Develop a solution plan for the given problem
Implementing the plan	Solve the problem based on the solution plan that has been planned
Checking back	Rechecking the solution results that have been written down

In Table 1, the indicators used are, understanding the problem, developing a plan, implementing the plan and checking back. The questions and learning activities in the module are designed using problem solving indicators. The instrument that has been designed then enters the validation and formative evaluation stages. The results of the validity questionnaire were subjected to a descriptive analysis based on the expert comments/suggestions received and the calculation of scores obtained from the validation sheet using the following formula:

$$Validity\ score = \frac{sum\ of\ the\ scores\ obtained}{total\ maximum\ score}\ x\ 100\%$$

Furthermore, the scores obtained were categorised based on the level of validity through the validity criteria used in this study which are presented in Table 2.

Table 2. Validity criteria

Validity Level	Validity Criteria
81% - 100%	Very Valid
61% - 80%	Valid
41% - 60%	Quite Valid
21% - 40%	Less Valid
0% - 20%	Invalid

Adapted from (Afifah et al., 2023)

The results of the score calculation were categorised according to the criteria in Table 2. In addition, the data from the practicality questionnaire was analysed by calculating the score using a Linkert scale score. The product usability criteria used in this study are presented in Table 3.

Table 3. Practicality criteria

Achievement Level	Category	Description
81% - 100%	Very Practical	Can be used without revision
61% - 80%	Practical	Usable with minor revisions
41% - 60%	Less Practical	Not recommended for use
21% - 40%	Not Practical	Unusable
0% - 20%	Not Very Practical	Unusable

Adapted from (Irawan & Hakim, 2021)

Results of the questionnaire score calculation were grouped according to the categories in Table 3. Then, test data analysis was conducted by examining the responses of students and assigning scores based on pre-established assessment criteria. The following qualitative value categories of mathematical problem-solving ability are presented in Table 4.

Table 4. Categories of qualitative scores of mathematical problem-solving ability

Rate	Category
81 – 100	Very good
61 – 80	Good
41 – 60	Enough
21 – 40	Less
0 – 20	Very Less

After the assessment, the students' mathematical problem-solving skills were grouped according to the categories in Table 4. Furthermore, the average total score was calculated and can be categorized again by Table 4. The interview data were analyzed using the descriptive method.

RESULTS AND DISCUSSION

This research produced a valid and practical problem-based module on comparison material, and has the potential to improve students' mathematical problem-solving skills through the use of teaching modules. The research employs two distinct stages:

Preliminary Stage

In the preparation stage, the researcher developed research instruments in the form of problem-based differentiated teaching modules. The researcher identified the school as the research site, which was junior high school 17 Palembang. Next, the researcher met with the principal of junior high school 17 Palembang to ask for research permission, which was then given to the class VII mathematics teacher. The results of the discussion with the mathematics teacher, obtained class VII.8 as the subject class for the field test and 4 students as the subject of the one-to-one trial and 6 students as the subject of the small group. Subjects were selected based on recommendations from subject teachers who have heterogeneous abilities and pay attention to students' learning styles.

The second stage is the analysis stage which consists of curriculum analysis, content analysis and student analysis. The objective of curriculum analysis is to ascertain the curriculum in use, namely the Merdeka curriculum. Researchers analyzed the curriculum of junior high school 17 Palembang with the help of mathematics teachers. The results of interviews with teachers, showed that the implementation of the Merdeka curriculum was not maximized, as indicated by the fact that the learning that was done did not facilitate students' learning styles. In addition, the researchers analyzed the learning outcomes of the number element. The content analysis is direct and inverse proportion. This material was chosen based on the results of discussions with the supervisor and the subject teacher who knew that comparison material is one of the most important materials to learn because the concept is very close to everyday life. Student analysis aims to identify the characteristics of students who will be involved in the research, in this case the researcher analyzed the VII grade students of junior high school 17 Palembang with the help of the subject teacher. The researcher conducted a student learning style test with the help of the *akupintar* website which can be accessed at the link: https://akupintar.id/tes-gaya-belajar. Researchers found that students tend to have visual and visual auditory learning styles.

The third stage, namely the design stage. Researchers designed a problem-based differentiated learning module on comparison material. This stage begins with formulating learning outcomes to determine learning objectives and appropriate learning activities. The design of the developed teaching module is shown in Table 5.

Table 5. Teaching module design

Teaching module components	Contents
General Information	1. Identity of the module: Name of author, subject, school, year, level/phase, domain/matter, class, time allocation. 2. Basic skills: Students will be able to find the greatest common factor, simplify fractions and algebraic expressions. 3. Profile of Pancasila Students: Belief and Piety in God Almighty, Cooperation, and Critical Reasoning. 4. Facilities and Infrastructure. 5. Target Learners. 6. Problem-based learning model with a scientific approach.
Core components	1. Learning Outcomes 2. Learning Objectives 3. Assessments used 4. Meaningful Understanding 5. Trigger Question
Learning Activities	1. Meeting 1 Learning is carried out by providing problem-based learner worksheets consisting of two different learner worksheets by paying attention to learning styles, in this case Visual-Auditory and Visual learning styles on direct proportion material. 2. Meeting 2 Learning is carried out by providing problem-based learner worksheets consisting of two different learner worksheets by taking into account learning styles in this case Visual-Auditory and Visual learning styles on the material of inverse proportion.
Assessment	1. Initial Assessment: Written Test 2. Formative Assessment: Problems on learner worksheets and videos from meetings 1 and 2. 3. Summative Assessment: Written Test
Reflection	1. Student Reflection 2. Teacher Reflection
Glossary	Key terms used.
Bibliography	References used.
Appendix	1. Pancasila Learner Profile Assessment (Attitude) 2. Initial Assessment Rubric 3. Summative Assessment 4. Summative Assessment Rubric 5. Teaching Materials 6. Learners' worksheet Meeting 1 & 2

In Table 5 the components used contain general information, core components, learning activities, assessment, reflection, glossary, bibliography, and appendix. Teaching modules are developed based on predetermined components.

Formative Evaluation Stage: Self-Evaluation

At this stage, several improvements were made to the teaching module, including: (1) eliminating the use of Quizizz in the learning process; (2) clarifying the core activities by differentiating students' learning styles; (3) changing the way students reflect by answering questions directly on the paper provided; (4) changing the form of questions in the initial assessment, which was previously multiple-choice to an essay form. The outcome of the revision at this juncture is designated as prototype 1.

Formative Evaluation Stage: Expert Reviews

The result of the next stage is to validate the teaching module by focusing on the components of the teaching module, namely the suitability of general information, core components and attachments. Validation was carried out by 2 mathematics education lecturers, initial JA and DO. A mathematics teacher, initial NA. The validation process results indicated that the teaching module was valid, with an average percentage of validity of 82.9%. However, further revisions were necessary considering the comments and suggestions provided by the validators. The comments/suggestions from the validators are presented in Table 6.

Table 6. Comments and suggestions along with revision decision

Validator	Comments/Suggestions	Revision Decision
JA	• Learning activities are adapted to the syntax of PBL as well as the steps used in the student worksheet.	• Learning activities have been improved as suggested.
	• Add the approach used in learning activities.	• The scientific approach has been added.
	• Replace question 1 with a more appropriate initial assessment.	• Question 1 for the initial assessment has been corrected.
	• Add 1 direct comparison problem instead of the story problem to the learner's worksheet.	• Direct comparison questions have been added.
DO	• Complete the learning objectives with elements A (Audience); B (Behavior); C (Conditions); D (Degree).	• Learning objectives are completed with elements of Audience; Behavior; Conditions; Degree.
	• Add captions for Pancasila learner profiles that appear in learning activities.	• In learning activities, information on the profile of Pancasila students has been added
	• Change the voice on the problem video in the learners' worksheet	• The sound in the problem video has been replaced.
	• Add the references used.	• References used have been added.
	• Replace 1 question in summative assessment with an analysis question.	• Summative assessment questions have been replaced with 1 analysis question.

Validator	Comments/Suggestions	Revision Decision
NA	• Add the video link of the problem in the learners' worksheet to the core activity. • Add indicators of problem-solving skills to the test questions	• Problem video links have been added to core activities. • Indicators of problem-solving skills have been added

In Table 6, comments/suggestions from validators are used as revision material to improve the product being developed. These results were used as the basis for revising prototype I to produce prototype II.

Formative Evaluation Stage: One To One

In addition to undergoing expert review, prototype 1 was subjected to testing by 4 students with 2 students each who have visual and visual auditory learning styles. Students were asked to work on student worksheets, then researchers observed students to find out what difficulties students encountered while working on student worksheets. After working on the worksheet, students were asked to write comments/suggestions on the sheet provided. The difficulties experienced by students are experiencing confusion about the reading material provided and lack of understanding in making inverse value comparison graphs. There were some comments and suggestions from 4 students after working on the student worksheet, namely for the worksheet of visual learning style, the appearance of the student worksheet is very interesting and easy to understand, except that the reading material presented should be more concise. Furthermore, for the worksheet of visual auditory learning style, the video display is interesting but the sound is less connected and the price list on the video can be enlarged. The differentiated learning module and learner worksheets validated at the expert review stage and one to one trials were revised to produce prototype 2 which is valid in terms of content, construct, and language.

Formative Evaluation Stage: Small Group

The outcomes of the prototype were then subjected to a preliminary evaluation involving two distinct groups of 3 students, each exhibiting a similar learning style and not directly related to the subject matter under investigation. The first group is a group of students with visual learning styles and the second group is a group of students with visual auditory learning styles. At this stage, the students were asked to complete the worksheet in groups. After completing the worksheet, each student was asked to complete the comment/suggestion sheet provided. The results of the students' comments and suggestions gave an overall positive impression of the worksheets provided. It was just that there is still a lack of time for them to discuss them. Furthermore, the students were presented with a practicality questionnaire, which was designed to assess the practicality of the worksheets utilized in the differentiated learning approach that has been developed. The questionnaire contains 10 questions with

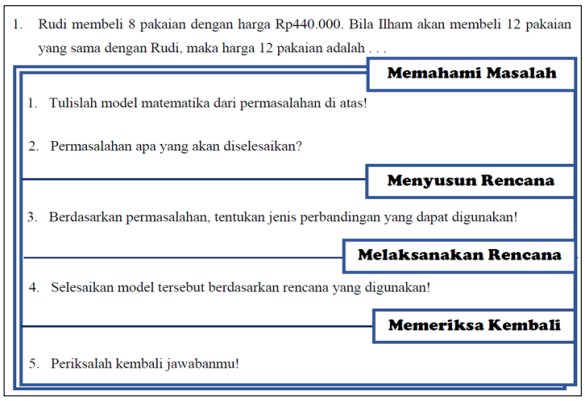
7 positive and 3 negative questions. Based on the answers to the questionnaire, the average percentage of answers was 83.3%. This showed that the developed product was included in the very practical criteria. Following the completion of the small-group trial and the incorporation of feedback from students, prototype 3 was developed and deemed a viable and effective product.

Formative Evaluation Stage: Field Test

The field test phase is the last phase of the formative evaluation, which was carried out over 3 sessions, with details of the first and second sessions, the learning process was carried out using a problem-based differentiated learning module on comparison material. In the learning process, the researcher acted as a subject teacher, this is because the researcher can maximally understand the characteristics of the research subject. Students were divided into 3 groups with visual learning styles and 3 groups with visual auditory learning styles. Each group consisted of 5-6 students. The learning process started with the teacher asking for the students' news, readiness to learn and asking one of the students to lead the prayer before learning. Then, the teacher checked the presence of the students and made an apperception of them through questions and answers. The teacher also invites the students to make a class agreement together. Then, the students were asked to do the initial assessment individually. Then the students were given worksheets and divided into 6 groups according to their learning styles. Students observed and discussed the problems on their worksheets with the help of learning resources prepared by researchers in the form of student handbooks, teaching materials and learning videos. When everyone had finished working on the worksheet, one of the group representatives presented their work and allowed the other groups to respond. Finally, the teacher provided reinforcement related to the learning process that had been completed and asked students to reflect on their learning.

The student worksheet used in the first session of differentiated learning contained problems presented in a coherent way using problem-based learning syntax with the same comparison material. Whereas the student worksheet used in the second session was the inverse value comparison material. The problems given to each group were the same, but the presentation was different according to the students' learning styles in class VII.8 junior high school 17 Palembang. For worksheets with visual learning styles, the problems presented were written directly on the worksheet and the reading material provided was in the form of a portable document files that students can access by scanning the QR code provided. On the other hand, for worksheets with an audio-visual learning style, the problems were presented in the form of videos as well as the learning material.

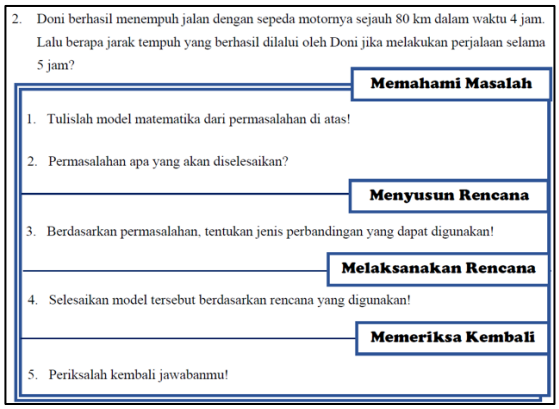
Following the learning process, students were required to complete three items of the test of students' mathematical problem-solving ability individually in the third session. Test questions 1, 2 and 3 are shown in Figure 2.



(a)

Translated into English:

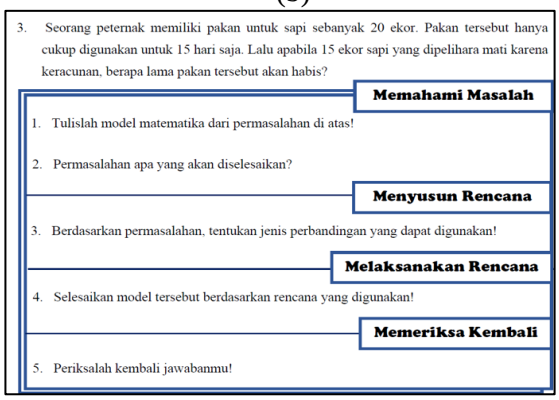
1. Rudi bought 8 clothes for 440.000 IDR. If Ilham will buy the same 12 clothes as Rudi, then the price of 12 clothes is . . .
   1. Write the mathematical model of the problem above.
   2. What problems will be solved?
   3. Based on the problem, determine the type of comparison that can be used.
   4. Solve the model based on the plan used.
   5. Check your answers again.



(b)

Translated into English:

2. Doni successfully travelled 80 km on his motorbike in 4 hours. What is the distance that Doni would have covered if he had travelled for 5 hours?
   1. Write the mathematical model of the problem above.
   2. What problems will be solved?
   3. Based on the problem, determine the type of comparison that can be used.
   4. Solve the model based on the plan used!
   5. Check your answers again.



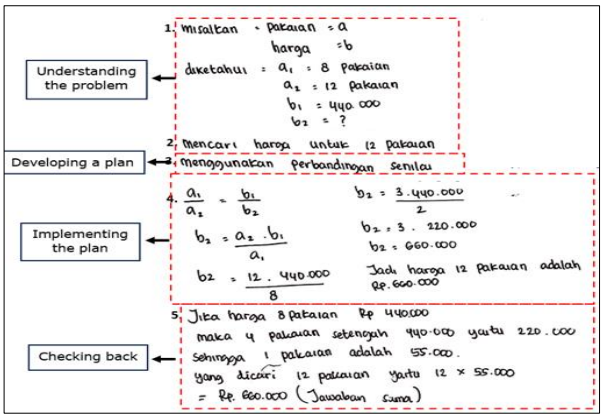
(c)

Translated into English:

3. A farmer has fodder for 20 cows. There is only enough feed for 15 days. If 15 of the cows die of poisoning, how long will take to run out of feed?
   1. Write the mathematical model of the problem above.
   2. What problems will be solved.
   3. Based on the problem, determine the type of comparison that can be used.
   4. Solve the model based on the plan used!
   5. Check your answers again.

Figure 2. Problem solving tests given to students

In Figure 2 (a) test question 1 and (b) test question 2, students were asked to solve the problem of valued comparison material. Furthermore, (c) test question 3, asked students to solve inverse value comparison problems by analysing the problems given. Each problem was answered coherently based on indicators of problem-solving ability. Based on the analysis of the results of students' answers to the test questions, 3 representative students were taken with high, medium, and low abilities respectively. The following are the answers of FT who are categorised as high ability students which can be seen in Figure 3.

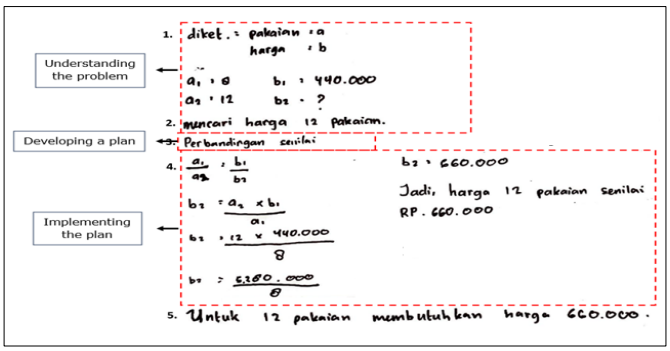


Translated into English:

1. For example: clothes = a; price = b
   Know: $a_1 = 8$ clothes
   $a_2 = 12$ clothes
2. Find the price for 12 clothes
3. Using value comparison
4. So, the price of 12 clothes is 660.000 IDR
5. If the price of 6 clothes is 440.000 IDR, then 4 clothes are half of 440.000 IDR. Which is 220.000 IDR. So, 1 clothes is 55.000 IDR. Find 12 clothes which is 12 x 55.000 IDR = 660.000 IDR (Same Answer)

Figure 3. FT answer on question number 1

Figure 3 shows that FT can fulfil all indicators of mathematical problem-solving ability. The initial indicator is identified by writing down the known facts and the questions that have been asked. FT can plan by determining the formula used. Furthermore, FT can carry out the plan correctly and precisely and can recheck the answer in another way. So, FT got a total of 16 points for test question number 1.

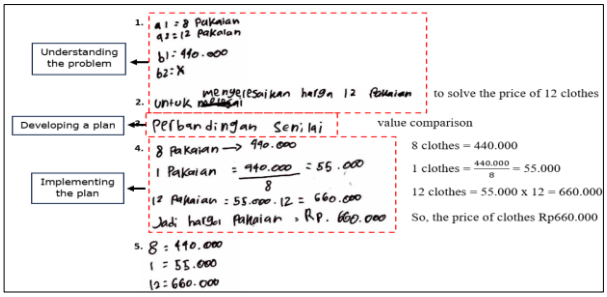


Translated into English:

1. For example: clothes = a
   price = b
   Known: $a_1 = 8$, $a_2 = 12$, $b_1 = 440.000$ IDR
   $b_2 = \ldots?$
2. Find the price for 12 clothes
3. Value comparison
4. So, the price of 12 clothes is 660.000 IDR
5. For 12 clothes requires a price of 12.000 IDR

Figure 4. AN answer on question number 1

Figure 4 shows that AN's answers are categorised as medium ability students. In working on test question number 1, AN fulfilled three indicators of problem-solving ability. The initial indicator is that AN can comprehend the issue by recording the available information and requesting further clarification. In the second indicator, AN can ascertain the strategy employed in solving the problem by means of a valued comparison. However, on the indicator of checking back AN still experienced confusion. This was clarified by the interview conducted where AN actually understood the meaning of checking back but was confused about applying it. So that the total points AN got were 12 points.

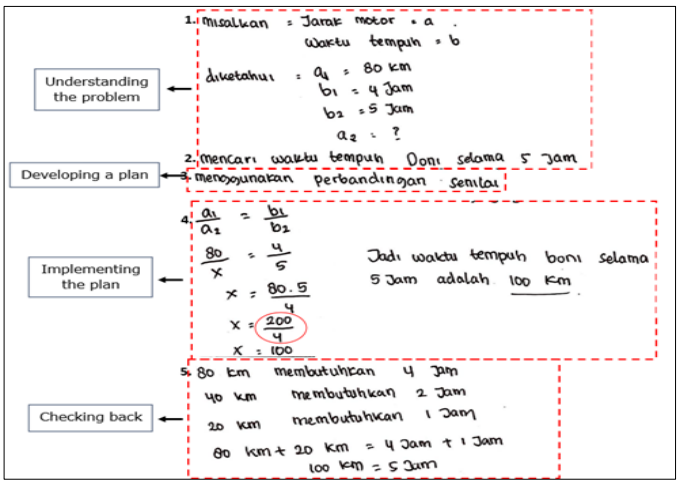


Translated into English:

1. $a_1 = 8$ clothes
   $a_2 = 12$ clothes
2. To solve the price of 12 clothes
3. Value comparison
4. So, the price of 12 clothes is 660.000 IDR

Figure 5. KR answer on question number 1

Figure 5 shows the results of KR responses, it can be seen that KR can meet three indicators and is in the low ability category. KR wrote down the information from the problem and solved it by first finding the price of 1 item of clothing and multiplying it by 12 to get the price of 12 items. However, the check back indicator did not appear because KR did not understand. This is clarified in the interview where KR thinks that checking back is just rewriting the answers that have been given. In test question number 1 KR got 12 points.

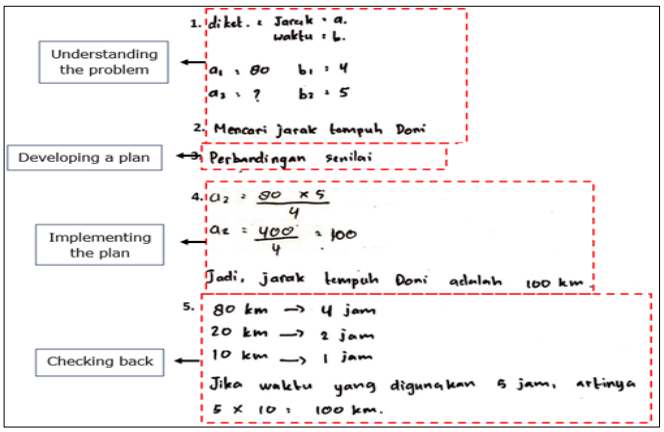


Translated into English:

1. For example: motor distance = a
   Travel time = b
   Know:
2. Find Doni's travel time for 5 hours
3. Using value comparison
4. So, Doni's travel time for 5 hours is 100 km
5. 80 km takes 4 hours
   40 km takes 2 hours
   20 km takes 1 hours

Figure 6. FT answer on question number 2

Figure 6 shows that FT can meet all the indicators of mathematical problem solving. The initial step is to identify the problem by articulating the known requirements and constraints. FT can also develop a plan by identifying the formula used. Furthermore, FT can carry out the plan correctly, it is just that there was a slight spelling mistake. In the last indicator, FT can check the answer in a different way. So, FT had a total of 15 points.



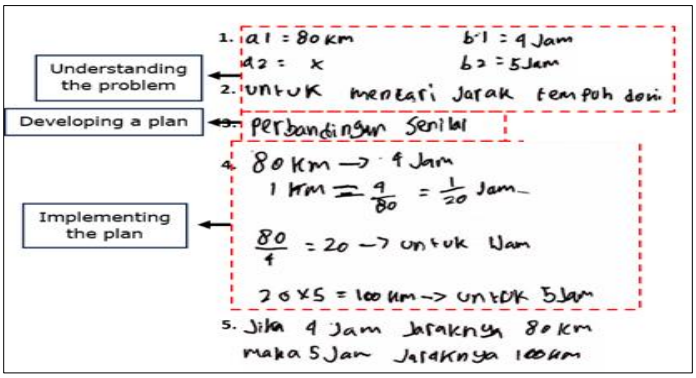
Translated into English:

1. For example: distance = a
   time = b
2. Find Doni's travelling distance
3. Value comparison
4. So, Doni's distance travelled is 100 km
   So, the time used is 5 hours,
   meaning 5 x 10 =100 km

Figure 7. AN answer on question number 2

Figure 7 shows AN answer for test question number 2. The figure indicates that AN could fulfil all the indicators of mathematical problem-solving ability. The initial indicator was that AN could comprehend the issue by articulating the pertinent information and questions pertaining to it. In the second indicator, AN can determine the type of comparison used, namely value comparison.

Furthermore, AN can solve the problem correctly, but it was not yet complete. In the last indicator, AN can check the answer by dividing distance and time together. So, AN got 15 points for test question number 2.

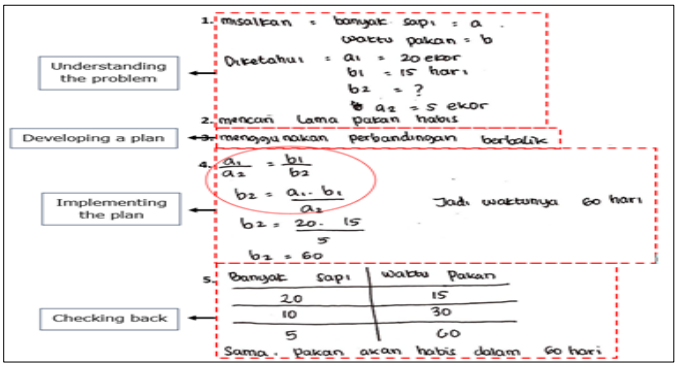


Translated into English:

2. To find Doni's travelling
3. Value comparison
5. If 4 hours is 80 km
   Then 5 hours is 100 km

Figure 8. KR answer on question number 2

Figure 8 shows the result of KR's answer. Just like the previous question, KR only fulfilled three indicators of mathematical problem-solving ability. In the indicator of carrying out the plan, to find Doni's distance travelled for 5 hours, KR first finds the distance travelled in 1 hour and then multiplies it by 5. Although he did not use the ratio formula, KR's method was correct. It was just that the indicator of checking back had not appeared. So, the points KR got for test question number 2 were 12 points.

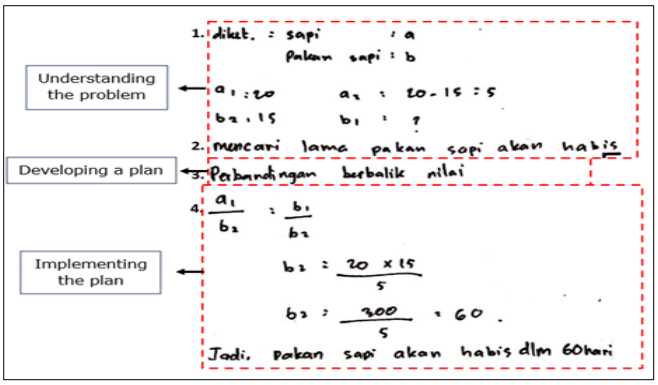


Translated into English:

1. If: many cows = a; feed time = b
   Known: $a_1 = 20$ cows
   $b_1 = 15$ days
   $a_2 = 5$ cows; $b_2 = ?$
2. Looking for a long time the feed will run out
3. Using inverse value comparisons
4. So, the time is 60 days.
5. Many cows, feed time same, the feed will run out within 60 days.

Figure 9. FT answer on question number 3

Figure 9 shows FT response to test question 3. Based on the answers FT has written, it can be seen that FT is able to meet all the indicators of mathematical problem-solving ability. However, there was a small error in the implementation of the plan indicator where FT wrote the inverse value comparison formula incorrectly but the calculation was correct. In the checking indicator, FT used a table to make it easier to compare the number of cows with their feeding time. The total score for FT was 15 points.

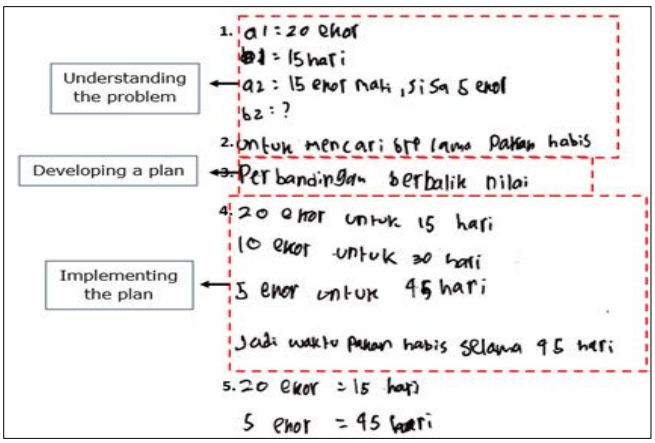


Translated into English:

1. Known: cows = a
   Feed time = b
2. Looking at how long the cows feed takes to run out.
3. Inverse value comparison
4. So, the cattle feed will run out in 60 days

Figure 10. AN answer on question number 3

Figure 10 shows AN answer to test question 3 It can be seen that AN only fulfilled three indicators of mathematical problem-solving ability. AN wrote down the information obtained from the problem and made a plan by determining the type of inverse value comparison needed to solve the problem. Then, AN was able to solve the problem by applying the inverse value comparison formula. However, the check back indicator did not appear because it was not answered. After confirmation during the interview, AN did not have time to answer the last part of number 3 and was still confused. So, that the total points obtained by AN in answering test question number 3 were 12 points.



Translated into English:

1. $a_1 = 20$ cows
   $b_1 = 15$ days
   $a_2 = 15$ cows dead, 5 left
2. To find how long the feed takes
3. Inverse value comparison
4. 20 cows for 15 days
   10 cows for 30 days
   5 cows for 45 days
   So, the feed time is up for 15 days
5. 20 cows = 15 days
   5 cows = 45 davs

Figure 11. KR answer on question number 3

Figure 11 shows KR answer to test question 3. It can be seen that KR only fulfilled three indicators of mathematical problem-solving ability. In the first indicator, KR wrote down the information obtained from the problem and the problem to be solved. Furthermore, KR was able to determine the type of comparison used. However, KR made a mistake in solving the test question. KR misinterpreted the concept of inverse value comparison. This was clarified by the interview conducted where KR considered that the way to find inverse value comparison was the same as value comparison only reversed. This understanding was wrong, so the researcher straightened out the concept of inverse value comparison to KR. The last indicator also did not appear, so the points obtained by KR were 10 points. Furthermore, calculation and analysis of students' mathematical problem-solving abilities were

carried out after previously describing the occurrence of indicators. The following table presents the results of the appearance of problem-solving ability indicators, as presented in Table 7.

Table 7. Occurrence of indicators of mathematical problem-solving skills

Indicator	Test Number 1	Test Number 2	Test Number 3
Understanding the problem	31	27	30
Developing a plan	21	22	24
Implementing the plan	35	36	30
Checking back	23	13	7

Table 7 shows that the indicator that appears the most from the three test questions was the indicator of carrying out the plan with the information of 35 students for question 1, 36 students for question 2 and 30 students for question 3. While the indicator that appeared the least was the indicator of checking with the information of 23 students for question 1, 13 students for question 2 and 7 students for question 3. After calculating each number of students who had raised the indicators in Table 7, the next step is to calculate the value of students' mathematical problem-solving ability. The following is a qualitative calculation of students' mathematical problem-solving ability in Table 8.

Table 8. Qualitative score of students' mathematical problem-solving ability

Score	F_1	F_2	F_3	$F_{totally}$
81 - 100	13	7	4	24
61 - 80	12	10	15	37
41 - 60	7	16	12	35
21 - 40	4	0	3	7
0 - 20	0	3	2	5
	36	36	36	

Table 8 presents the number of students in each score range. It can be seen that in the range 80 - 100 there were 13 students for test question 1, 7 students for test question 2 and 4 students for test question 3. The next step is to calculate the average mathematical problem-solving ability of students, which can be seen in Table 9.

Table 9. The average mathematical problem-solving ability of students

Score	F_1	F_2	F_3	$F_{totally}$	X_i	$F_{totally} . X_i$	Average
81 - 100	13	7	4	24	90,5	2172	63,069
61 - 80	12	10	15	37	70,5	2608,5	
41 - 60	7	16	12	35	50,5	1767,5	
21 - 40	4	0	3	7	30,5	213,5	
0 - 20	0	3	2	5	10	50	
a	36	36	36	108		6811,5	

Table 9 presents the mean value of mathematical problem-solving ability among students in class VII.8 SMP N 17 Palembang which is included in the good category after learning using a problem-based differentiated module on comparison material.

This research focused on developing modules for problem-based differentiated learning on valid and practical comparison materials. Mathematical problem-solving skills are needed for students to train so that students are used to dealing with complex problems not only in mathematics problems but in other subjects and in everyday life. This is in line with the opinion of Sriwahyuni & Maryati (2021) the ability to solve problems is essential in learning mathematics because it does not only prioritise results but prioritises the processes and strategies that students carry out in solving problems. The material used in this study is comparison material because it is very close to everyday life. This is reinforced by Nabila et al. (2024) the concept of comparison is often used in real life; for example, in making food, the comparison between the amount of flour and sugar used. This research uses problem-based learning which can potentially improve students' mathematical problem-solving skills (Juliyanto et al., 2022). The characteristics of the teaching module developed are by taking into account the needs and learning styles of students. Through differentiated learning activities, students will show good performance and provide opportunities to work in the way they like (Naibaho, 2023).

Differentiated Learning Module (Valid and Practical)

After validation by two mathematics lecturers and one mathematics teacher and tested with four students face-to-face, the product was considered valid. Comments or suggestions given by validators are used to improve the product that has been developed (Farida et al., 2022). The conclusion that a product is valid can be reached through the use of indicators based on content validity (material) and construct validity (the relationship between one component and another) (Yuliani & Irham, 2022). Products that are declared valid can be tested on small groups and then given a student response questionnaire to assess the practicality of the product that has been developed. The revision stage is carried out in accordance with the comments/suggestions and difficulties experienced by students. The results of students' comments and suggestions overall gave a positive impression only in terms of processing time was still lacking for them to discuss. The revised product was subjected to a field test on a large group of subjects.

Potential Effects of Using Problem-Based Differentiated Learning Modules

The field test stage was conducted for three meetings. In the first and second meetings, learning activities were carried out in accordance with the differentiated learning module that had been developed. Students were instructed to work on problems presented in the learner worksheet in groups. Furthermore, during the third meeting, students worked on three test items. The purpose of conducting this test is to find out how good students' mathematical problem-solving skills are. The test questions

given are in the form of story problems that have been adapted to problem solving skills. By solving story problems, students can improve their problem-solving skills (Suratih & Pujiastuti, 2020). The indicators of problem-solving ability include understanding the problem, developing a plan, implementing the plan, and checking again.

Understanding the Problem

Understanding the problem is the first indicator of problem-solving ability. This indicator appears if students can identify the information given and what problems will be solved. Based on the results of student analysis, 31 students met the indicator of understanding the problem in problem number 1, 27 students met the indicator of understanding the problem in problem number 2, and 30 students met the indicator of understanding the problem in problem number 3. Students should write down what is known and asked so that it makes it easier to solve the answer (Arifin & Zaenal, 2024).

The second indicator of students' mathematical problem-solving ability is planning. This indicator is said to appear if students can choose the right strategy to use in solving the problem given by connecting the information that has been obtained. In this indicator, 21 students have demonstrated the ability to plan in response to problem number 1, 22 students have demonstrated the ability to plan in response to problem number 2, and 24 students have demonstrated the ability to plan in response to problem number 3. According to Rusani et al., (2021) the stage of planning is said to be achieved if students can choose a way to solve the problem.

Implementing the Plan

The third indicator of students' mathematical problem-solving ability is implementing the plan. The indicator of implementing the plan is said to appear if students can carry out the strategy they have chosen in the previous stage and interpret the information given into mathematical form with accuracy until they get the solution results. The indicator of implementing the plan appears the most even though there are still some student answers that are not entirely correct. In this indicator, 35 students have demonstrated the ability to plan in response to problem number 1, 36 students have demonstrated the ability to plan in response to problem number 2, and 30 students have demonstrated the ability to plan in response to problem number 3. This is in line with the opinion of Fitriyana & Sutirna (2022) that in the calculation process students tend to be less careful.

Checking Back

The fourth indicator of students' mathematical problem-solving ability is checking back. This indicator is said to appear if students can evaluate or recheck whether the strategy used and the results obtained are correct. The alternative is that students can use other methods to check whether the answers obtained are correct Based on the results of student analysis, it was found that 23 students fulfilled the

indicator of checking back in problem number 1, 13 students who fulfilled the indicator of checking back in problem number 2, and only 7 students who fulfilled the indicator of checking back. This indicator is least prevalent because students lack an understanding of the problem and are not accustomed to verifying the answers they have obtained. This is in line with the results of research conducted by Fitriyana & Sutirna (2022) that the number of students who are correct in answering based on the indicator of checking back gets the lowest percentage of 10% or only a small percentage of students who check back their answers. The reason this indicator is rarely observed is that the majority of students neglect the question prompts, preferring to look back. Furthermore, students believe that they have acquired sufficient knowledge of the final results without re-analysing the results that have been obtained (Hanifa et al., 2019) Although the indicators of mathematical problem-solving ability have not fully appeared, the use of problem-based differentiated learning modules on comparison material is categorised as good for the mathematical problem-solving ability of students in class VII.8 junior high school 17 Palembang.

CONCLUSION

This problem-based differentiation learning module with comparison material is declared valid and practical. The validity of the product is seen from the results of comments and suggestions from validators, with an average percentage of 82.9%, which shows that it is quite valid. In addition, the practicality of the product is seen from the results of the questionnaire given at the small group stage, with a percentage of 83.3%, which is included in the very practical category. The characteristics of the resulting teaching module are that students are grouped according to their learning styles, including two learning styles used, namely visual and visual auditory and the questions used are problem solving questions. The results of the research obtained a score of 63.069 which states that students' mathematical problem-solving abilities are good, with the indicator that appears the most being the indicator of carrying out the plan and the indicator that appears the least is the indicator of checking again. Suggestions for other research to conduct similar research by paying attention to other learning styles such as kinesthetic learning style, audio learning style, audio kinesthetic learning style.

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