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Problem Based Learning Module on Linear Function to Facilitate Mathematical Problem-Solving Skills

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Abstract
This research aims to develop a teaching module based on the Problem Based Learning (PBL) model to facilitate students' Mathematical Problem Solving Skills (MPSS) on the topic of linear functions. The development process employed a modified 4-D model (Define, Design, Develop, and Disseminate) proposed by Thiagarajan. The trial subjects were students of Class VIII-3 at SMP Muhammadiyah 1 Pekanbaru. The feasibility of the module was assessed in terms of content accuracy, alignment with learning objectives, instructional usability, and visual presentation. The results showed that the module achieved a very valid category with an average score of 3.36 and a percentage of 83.97%. The practicality tests obtained an average score of 3.71 (92.72%) in the small-group trial and 3.59 (89.75%) in the field trial, both classified as very practical. These findings confirm that the developed module meets the required standards of validity and practicality, making it suitable for use in teaching and learning activities.

Keyword: teaching module, problem based learning, problem solving skills, linear function.

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Introduction

In an effort to improve the quality of post-pandemic learning, the Ministry of Education, Culture, Research, and Technology has formulated a strategic policy by providing three alternative national curricula, including the Independent Curriculum. This curriculum is designed to create a flexible and enjoyable learning environment, thus encouraging students to develop their potential more optimally (Kemendikbudristek, 2021). The Merdeka Curriculum is also oriented towards strengthening 21st century competencies, which are seen as a set of essential skills to face future global dynamics. These competencies include: 1) Communication, 2) Collaboration, 3) Critical thinking and Problem Solving, 4) Creativity and Innovation. (Nesri & Kristanto, 2020).

The superior generation needs to be prepared to compete in facing the challenges of the 21st century, one of which is by studying Mathematical Problem Solving Skills (MPSS) (Kurniawati et al., 2019). According to Syahril et al. (2020) Mathematical problem solving skills are important for students to have, in line with this opinion, Fitri et al. (2020) expressed the importance of KPMM by students, namely: 1) the ability to solve problems is the general goal of teaching mathematics; 2) the main and central activity in the independent curriculum

is problem solving, which includes models, processes, and techniques; and 3) problem solving is a fundamental ability in mathematics education.

According to research by Ostika et al. (2021) at SMPN 1 Banda Aceh, researchers found students with low MPSS. The level of students' ability to solve problems related to linear equation material is still relatively low. This is reflected in the results of the initial evaluation which showed that half of the students had difficulty understanding the meaning of the questions and the steps to solve them. This condition has an impact on the inaccuracy in drawing correct conclusions from the problems presented. Teachers must be able to help students' MPSS during the learning process, and Indriani et al. (2024) stated that poor MPSS is caused by students who do not practice enough in working on real-world practice questions.

The results of interviews with several mathematics teachers at SMP Muhammadiyah 1 Pekanbaru revealed that currently they do not have a special learning module on the material of linear equations. This condition has an impact on the low active participation of students in mathematics learning activities, where the role of teachers still dominates as the main source of information. Meanwhile, at SMPN 29 Pekanbaru, mathematics teachers said that the learning process still relies on Student Worksheets and additional notes prepared by teachers as supporting materials, which shows the limited variety of learning resources used. Students are quite competent in understanding problems, making plans, and solving difficulties when using MPSS, and teachers remain the center of attention in the learning process. Meanwhile, the reinterpretation indicator is quite low because students mostly forget to emphasize the answers.

The effectiveness of the learning process is highly dependent on the quality of the planning that has been prepared beforehand. In this context, learning planning functions as the main guideline for educators in compiling and directing learning activities so that they take place systematically and efficiently (Maulida, 2022). Meanwhile, Mulyani and Insani (2023:3) explain that in the implementation of the Independent Curriculum, the term learning planning is better known as a "teaching module". This module is prepared by considering the characteristics and needs of students, so that it can accommodate the achievement of learning objectives optimally (Gawasa, 2022). The open module components contain general information, core components, and attachments (Maulida, 2022). The developed module will be tested for its feasibility first, namely validation will be carried out first to see the validity and practicality of the teaching module.

To improve students' MPSS abilities, it is necessary to develop teaching modules based on the conditions mentioned. To optimize the achievement of mathematics learning objectives, it is necessary to design teaching modules that can increase students' active participation during the learning process in the classroom. Based on previous research conducted by Syahril et al. (2023), valid and useful teaching modules consisting of three parts, namely general information components, core, and attachments, can support MPSS and LKPD, which are made in such a way that the material is visually attractive for students to use as a learning aid and facilitate students' understanding because it is related to the problems they face in everyday life.

In order to improve KPMM at a low level, it is important for teachers to create a space that encourages students to develop critical thinking and express ideas independently. To realize this, teachers need to apply a learning approach that is in line with the characteristics of students, while designing questions that can bridge conceptual understanding of mathematical material. One approach that is considered effective in building these skills is the Problem Based Learning (PBL) model, which is considered capable of introducing problem-solving strategies based on real experiences that are close to students' lives (Soniawati, 2022). In this context, the development of teaching modules is focused on the topic of linear equations, a topic in the mathematics curriculum for grade VIII SMP/MTs

which has a strong connection to everyday situations. However, this topic tends to be abstract so that it is not easy to understand only through a symbolic approach. Therefore, presenting material in a real-life context is very important to overcome these obstacles. Unfortunately, the reality in the field shows that some students still have difficulty in linking these concepts to their experiences, which indicates that learning objectives have not been achieved optimally.

Referring to the previous background explanation, this study aims to contribute to strengthening students' MPSS through the development of PBL-based teaching modules that focus on linear equation material. The researcher believes that the learning process will be more meaningful if students are encouraged to build their knowledge independently and are given space to be actively involved in learning activities. Based on this belief, the development of this module is based on the need to produce teaching tools that are not only theoretically valid but also practical in their application.

Method

Based on the adaptation of the 4-D model (Define, Design, Develop, and Disseminate) conducted by Thiangarajan, the research conducted by the researcher is development or often referred to as research and development or R&D. The development process is then explained in more detail using the 4-D development paradigm. To find out the problems found and the character of the students, the researcher conducted observations and interviews with mathematics teachers of SMP Muhammadiyah 1 Pekanbaru in the first stage, namely define. This stage is continued with idea analysis, exercise analysis, media analysis, and learning objective planning. The next stage is the design stage, namely the researcher makes a draft of 1 product or product plan to be implemented. This stage includes making validation and practicality sheets, media selection, formatting, and making basic product designs. The next stage is the development stage, namely the stage where the product that has been made in the design stage is realized. Furthermore, structured development is carried out, starting with validation by two experts (mathematics education lecturers) and a practitioner (junior high school mathematics teacher), then revised based on the validator's recommendations. After that, the product was tested on subjects at SMP Muhammadiyah 1 Pekanbaru. First, the product was read by three different students, then revised based on feedback. Furthermore, the product was tested on small groups consisting of a maximum of six students, and finally revised and tested in the field to 26 students in grades VIII-3 with various skill levels to get feedback. The formative evaluation flow can be seen in Figure 1.

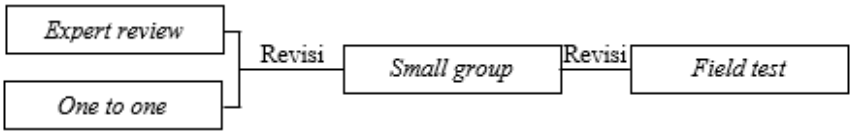

Figure 1. Formative Evaluation Flow

The last stage is disseminating, the stage of distributing printed teaching modules so that they can be used and seeing the results of achieving the objectives in the form of a seminar on the results of development research. Qualitative and quantitative data are generated by this research test. Qualitative data are collected through observation, interviews, and feedback from students and validators. Quantitative data are obtained from student response surveys and validation sheets, which are instruments for evaluating and disseminating products that are made so as to produce measurable data. The validation instrument in this study assesses the visual quality and content of the teaching module, as well as its suitability with the PBL approach, KPMM, and didactic, constructive, and

technical principles. Meanwhile, the response questionnaire is designed to evaluate the design of the LKPD, the clarity of information delivery, and its functionality, using a four-point Likert scale as a measurement tool for validity and practicality. The steps taken in the validation and practicality of the development of the teaching module are as follows:

a. Analyze the validation table from the validators and the practicality table from the students.
b. Average validation and practicality results modified from Sudijono in Seprianti et al. (2022) with the following formula.

$$\bar{X}_V = \frac{\sum_{i=1}^{n} \bar{V}i}{n}$$

Description:
$\bar{X}_V$ = Average total validity
$\bar{V}i$ = Average total validation of the-i the validator
n = Number of validators

$$\bar{X}_P = \frac{\sum_{i=1}^{n} \bar{P}i}{n}$$

Description:
$\bar{X}_P$ = Average total practicality
$\bar{P}i$ = Average total practicality
n = Number of learners

c. Matching the validation average with the validation suitability criteria for the teaching module that has been modified by the researcher in Tables 1 below.

Table 1. Average Validity Criteria of Teaching Modules

Intervals	Level Valid	Level Praktis
1,00 ≤ $\bar{X}$<1,75	Not Valid	Not Praktis
1,75 ≤ $\bar{X}$<2,50	Less Valid	Less Praktis
2,50 ≤ $\bar{X}$<3,25	Valid	Praktis
3,25 ≤ $\bar{X}$<4,00	Very Valid	Very Praktis

Source : Modification Sa'adun Akbar (2017)

d. Calculating the validity and practicality score in percentages adapted from Sa'adun Akbar (2017) with the following formula.

$$P_V = \frac{TSv}{TSh} \times 100\%$$

Description :
P_V = Validity Percentage
TSv = Total empirical score from the validator
TSh = Total maximum expected score

$$P_p = \frac{TSp}{TSh} \times 100\%$$

Description :
P_p = Practicaliy Percentage
TSp = Total empirical score from the learners
TSh = Total maximum expected score

e. Validity/ Practicality percentage criteria are adjusted according to Akbar (2017:41) which is presented in Table 2 and 3 below.

Tabel 2. Average Validity Criteria for Teaching Modules

Interval	Kriteria
$80{,}00\% < P_V \leq 100{,}00\%$	Very valid, or can be used without correction.
$60{,}00\% < P_V \leq 80{,}00\%$	Fairly valid, or usable but needs minor improvements
$40{,}00\% < P_V \leq 60{,}00\%$	Less valid, or recommended not to be used.
$20{,}00\% < P_V \leq 40{,}00\%$	Invalid, or cannot be used.
$00{,}00\% < P_V \leq 20{,}00\%$	Completely invalid, or completely unusable.

Source: Modification Sa'adun Akbar (2017)

Tabel 3. Average Practicality Criteria for Teaching Modules

Interval	Kriteria
$80{,}00\% < P_V \leq 100{,}00\%$	Very practical, or can be used without correction.
$60{,}00\% < P_V \leq 80{,}00\%$	Fairly practical, or usable but needs minor improvements
$40{,}00\% < P_V \leq 60{,}00\%$	Less practical, or recommended not to be used.
$20{,}00\% < P_V \leq 40{,}00\%$	Inpractical, or cannot be used.
$00{,}00\% < P_V \leq 20{,}00\%$	Completely inpractical, or completely unusable.

Source: Modification Sa'adun Akbar (2017)

A learning module can be said to be valid and practical if its validation and practicality levels reach at least 61%. If the module is assessed as less valid or less effective, then a revision is needed until it meets the validity and practicality standards.

Result and Discussion

Define Stage

The researcher identified the main problems faced by students related to the low ability of Independent Mathematical Understanding in the implementation of the Independent Curriculum in Indonesia. Therefore, the development of a learning module is a necessary step. Data collection was carried out through interviews with mathematics teachers at SMP Muhammadiyah 1 Pekanbaru and SMPN 29 Pekanbaru. In addition, observations at SMP Muhammadiyah 1 Pekanbaru revealed a lack of student interest in playing an active role during mathematics learning. At the module development stage, the material was systematically and in detail arranged into four subtopics, each covering two hours of teaching time. Details of the division of subtopics are presented in Table 4 below.

Tabel 4. Details of Learning Subtopics

Subtopic	Learning Subtopic	Time Allocation
1	Linear Function	2 JP
2	Graphs Linear Functions with Gradien	2 JP
3	The Relationship Between Two Straight Lines	2 JP
4	Other Forms of Linear Equations	2 JP

Design Stage

The researcher made an initial product design that was adjusted to the preparation of the teaching module and the preparation of the validity and practicality instruments of the teaching module. The validation sheet includes validation of identity and general information, validation sheet of core components and validation sheet of attachments. The practicality questionnaire sheet designed is a student response questionnaire sheet that includes aspects of presentation of material in the LKPD, ease of use and appearance of the LKPD. The practicality questionnaire sheet is given to students with heterogeneous abilities. Then the selection of media is carried out to be used as a guide for learning activities. The next stage is to create a design of a teaching module that refers to the 2024

BSKAP of the Ministry of Education and Culture concerning learning and assessment guidelines and the student worksheets that are developed contain KPMM indicators and use PBL stages. The teaching module developed includes LKPD as a supporting media for student learning activities. The LKPD consists of a cover and contents. On the LKPD cover there is information about student identity, material to be studied, learning objectives, and filling instructions. Meanwhile, the contents of the LKPD contain a presentation of contextual problems that are arranged based on the stages of PBL learning. An example of the cover display can be seen in Figure 2 below.

Figure 2. Cover Section of LKPD

Development Stage

After consulting with the supervising lecturer, the prepared teaching module was modified based on the lecturer's recommendations and comments. In addition, three validators underwent a validity test. 1) The lecturer in Mathematics Education, Riau Islamic University, specialized focus on educational evaluation and curriculum instruction. 2) The lecturer in Faculty of Tarbiyah and Teacher, UIN Sjech M. Djamil Djambek 3) Junior Expert Teacher Mathematics at SMPN 37 Pekanbaru. The module obtained a mean score of 3.36 (83.97%), classified as very valid. This result aligns with the findings of Çetinkaya & Kıymaz (2024), who stated that instructional materials integrating clear content, visual appeal, and appropriate learning models achieve high validity. It also meets the standards of instructional design proposed by Dick & Carey (2015). Small-group trials yielded 3.71 (92.72%) and field trials 3.59 (89.75%), both very practical. These results are consistent with Ariawan et al. (2022) and Kaur & Rawat (2025), who reported that PBL-based modules are easy to use and increase student motivation. Furthermore, the use of contextual problems supports the constructivist principle that knowledge is built through experience (Argüelles-Cruz et al., 2023). The module addresses the abstract nature of linear functions by presenting problems such as transportation costs, water usage, and service tariffs. This approach matches the recommendation of Rehman et al. (2023), who emphasized that contextual tasks help students develop both conceptual understanding and problem-solving skills. Figures 3 and 4 below show a number of improvements made to the open module.

Figure 3. Concept map before revision

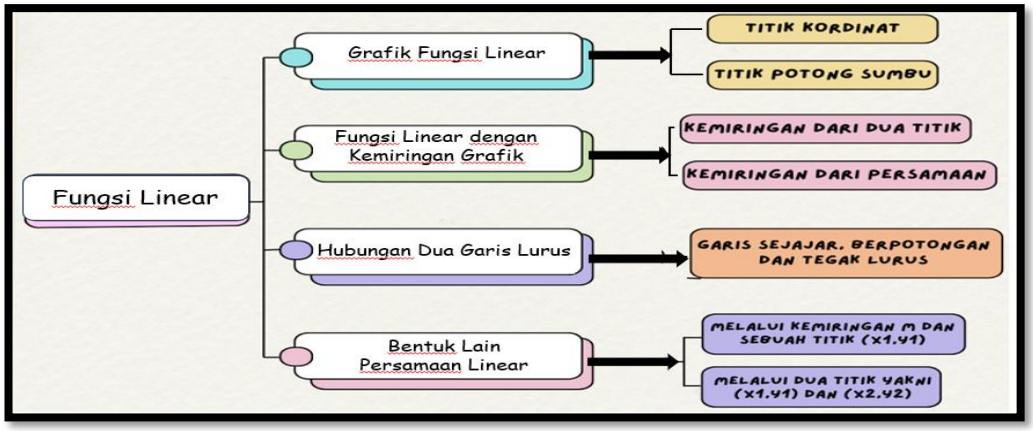

Figure 4. Concept Map After Revision

In Figure 4, the concept map is too ordinary so the validator suggests making it more interesting. Other suggestions include adding benefits that students can get in real life. The results of the revision can be seen in Figure 6. After being validated and revised based on input from students and validators, the teaching module was tested on six students in small groups. After receiving the LKPD, students were asked to read the instructions for use and complete their identity forms. After completing the LKPD provided, students asked questions to the researcher if they did not understand any information, and then they were given a questionnaire to fill out. Table 5 below displays the findings from the small group response questionnaire.

Tabel 5. Findings from the Student Response Questionnaire for Small Groups

Aspect		Student assessment on the LKPD				Score	Level
		1	2	3	4		
LKPD Display	Average	3,77	3,73	3,8	3,67	3,74	Very Practical
	Percentage	94,17%	93,33%	95%	91,67%	93,54%	
LKPD Material Presentation	Average	3,71	3,65	3,56	3,65	3,64	Very Practical
	Percentage	92,70%	91,15%	89,06%	91,15%	91,02%	
Ease of Use LKPD	Average	3,76	3,76	3,79	3,67	3,75	Very Practical
	Percentage	94,05%	94,08%	94,64%	91,67%	93,61%	
		Total Average				**3,71**	**Very Practical**
		Total Percentage				**92,72%**	

Source : Researcher DataProcessing, 2025

After revising the feedback and recommendations from the small group trial, 26 students from SMP Muhammadiyah 1 Pekanbaru class VIII-3 participated in the large group trial. Table 6 below displays the findings from the large group student response questionnaire.

Table 6. Findings from the Student Response Questionnaire for Large Groups

Aspeks		Student assessment on the LKPD				Score	Level
		1	2	3	4		
LKPD Display	Average	3,55	3,62	3,61	3,6	3,60	Very Practical
	Percentage	88,85%	90,6%	90,19%	90%	89,91%	
LKPD Material Presentation	Average	3,52	3,61	3,62	3,70	3,61	Very Practical
	Percentage	87,98%	90,13%	90,50%	92,43%	90,26%	
Ease of Use LKPD	Average	3,52	3,55	3,59	3,59	3,56	Very Practical
	Percentage	88,05%	88,86%	89,70%	89,70%	89,08%	
Total Average						**3,59**	**Very Practical**
Total Percentage						**89,75%**	

Source : Researcher DataProcessing, 2025

Based on the findings of small group and large group trials, it shows that the resulting teaching module has been declared valid and practical, so it is suitable for use in learning activities.

Dissemination Stage

Packaging the teaching module as a book and sending it to mathematics teachers is the final step in the development process. It is expected that teachers will use the teaching module as a guide to create their own lesson plans and incorporate it into their learning practices. As seen in Figure 5 below, the open module is packaged like a book with a cover section.

Figure 5. Cover of Teaching Module

The teaching module that the researcher developed also has weaknesses, namely during validation, the researcher received suggestions in the form of meaningful understanding that the researcher created was the concept of each meeting of the linear equation, meaningful understanding should contain problems that make students find benefits from the activities carried out, so that the researcher has improved the meaningful understanding of each meeting in the teaching module. In addition, so that learning is not boring, the validator's recommendation regarding the MPSS indicator for developing and presenting student work results suggests that the results of problem solving in LKPD be presented in a more interesting way, such as on cardboard, PowerPoint, or other media. However, due to the limitations, the researcher has not implemented the validator's recommendations. During the field test process, the researcher also received suggestions to add more space to write answers. The product trials of readability and small groups that the researcher conducted were only in one class but with different students in order to get various input from various understandings. It is better if the product trials are carried out by students from different classes so that a broader and deeper understanding of the product being developed is obtained. Therefore, it is hoped that the shortcomings in this study can be improved and become input for subsequent studies that want to conduct research with the same problems.

Conclusion

This development aims to create a problem-based teaching module on the topic of linear functions. The structure of the learning module consists of three main parts, namely general information, core components of the material, and appendices. The material is arranged for implementation in four meetings, with a learning focus on the material of linear equations. This module based on the Problem Based Learning (PBL) approach is designed to improve mathematical problem-solving skills in phase D students, and has been proven valid based on a feasibility test. In addition, research findings show that this module also meets the criteria for practicality in terms of implementation in the field. Further research is suggested by the researcher, who first recommends a more comprehensive analysis of the effectiveness of the teaching module. Second, the researcher recommends the use of the PBL learning model or other learning models to create teaching modules with different levels and materials.

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