

Development of a Module with a RME Approach on the Topic Systems of Linear Equations in Two Variables

Leni Agustina Daulay¹, Bettri Yustinaningrum², Feri Tiona Pasaribu³, Sri Lestari Manurung⁴, Erika Putri⁵

^{1&5} Institut Agama Islam Negeri Takengon, Aceh Tengah, Indonesia.

² Universitas Islam Negeri Sayyid Ali Rahmatullah Tulungagung, Jawa Timur, Indonesia.

³ Universitas Jambi, Jambi, Indonesia.

⁴ Universitas Negeri Medan, Sumatera Utara, Indonesia.

* Correspondence to: agustina_leni@yahoo.com

Abstract: This research seeks to create legitimate and practical teaching materials in the form of a module utilizing a realistic mathematics education approach focused on the topic of systems of linear equations in two variables. This study utilizes the research and development (R&D) approach, specifically the Thiagarajan 4-D model, which consists of four stages: (1) definition, (2) design, (3) development, and (4) dissemination. We conducted the research at MTsN 1 Central Aceh. Two classes, each with high and moderate abilities, participated in the research. The trial analysis yielded the following findings: (1) Validity, as two experts validated the teaching materials; (2) Practicality, as demonstrated by an average implementation of the learning syntax exceeding 75%, an average student activity exceeding 75%, extremely positive student and teacher responses to the module, and a classification of the developed module as practical. According to the results of the students' learning tests, 15 students completed the requirements out of 19 students in the high-ability class, and 14 students completed the requirements out of 19 students in the medium-ability class. Consequently, we categorize the percentage of students who have met the requirements as excellent. The module created utilizing a realistic mathematics education technique for the topic of systems of linear equations in two variables for eighth grade is deemed viable, indicating it is both valid and practical.

Keywords: Module; realistic mathematics education; system of linear equations in two variables.

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INTRODUCTION

Today, mathematics is still considered a difficult subject for students to understand. Several issues arise during the process of learning mathematics, resulting in students not fully understanding the material they are currently studying or even the material they have already learned (Farida; Hartatiana; Watcharin, 2019). In general, when facing a subject that is considered difficult, students tend to show low interest in learning, low achievement motivation, and poor learning outcomes (Hendriana & Fitriani, 2019).

The current process of learning mathematics is still considered a failure in actively involving students. The process of learning mathematics is still teacher-centered, where the teacher actively provides information but does not introduce problems, resulting in students only passively receiving knowledge (Fitriani et al., 2018). However, given the significance of mathematics education, educators must foster an environment and

methodology that can captivate students' interest and transform their mindset and viewpoint towards mathematics learning.

Adequate learning tools must also support the success of a learning process. Teaching materials are one of the essential components of the learning process (Bashith et al., 2019). Books, serving as teaching materials and learning resources, play a crucial role in determining the success of learning implementation. The Indonesian government is presently releasing textbooks for the 2013 curriculum, including mathematics, for students and educators in schools. We anticipate that this book will aid both students and educators in executing their learning activities in line with the current curriculum.

However, based on previous studies, researchers determined that textbooks have not yielded the most favorable outcomes when it comes to instructing students (Wahyudi et al., 2017). Educators have not created instructional materials to facilitate the learning process, and students continue to encounter challenges in comprehending textbook content in the classroom. We aim to ensure that students can access educational resources at any time and from any location, thereby extending the learning process beyond the classroom.

Furthermore, in order to captivate students' interest in learning through the use of teaching materials, they must possess a distinctive and captivating form, content, and presentation method (Nuraina et al., 2021). The development of a module serves as a compelling educational instrument. A module, a self-sufficient and thorough entity, comprises a sequence of educational activities aimed at assisting learners in attaining distinct and explicit objectives (Susanto et al., 2024). Learners can study autonomously, with or without teacher guidance, and they control their learning outcomes by utilizing modules. Each module implements competency standards that students must meet to achieve this. Consequently, students are more accountable for their actions.

The Realistic Mathematics Education (RME) approach is one of the learning approaches that can change students' mindsets towards mathematics (Alim et al., 2021). RME is a form of learning approach that utilizes the real world and emphasizes student activities to search for, discover, and construct their own necessary knowledge, making the learning process more student-centered (Arsaythamby & Zubainur, 2014).

RME is a mathematics learning approach that encourages students to implement the learning material they receive into their daily lives (Ndiung et al., 2021). The teacher guides the students to discover or construct the concepts they are learning on their own, rather than directly providing formulas or concepts during lesson delivery. In the application of the RME approach, the teacher acts as a guide by providing students with the opportunity to learn actively (Armianti & Sutiaharni, 2021). This aims to transform the learning activities from being teacher-oriented to student-oriented (Karaca & Özkaya, 2017).

The observations from MTsN 1 Central Aceh showed that the school is already making good progress in mathematics teaching. Nevertheless, the learning activities remain centered around the teacher. During the learning process, the teacher employs lecture and question-and-answer techniques. Teachers also rarely, if ever, develop their own additional teaching materials, such as modules. The abundance of ready-to-use teaching materials eliminates the need for teachers to create their own materials. However, the lack of modules leads students to primarily listen and take notes, which in turn contributes to inactive learning that does not engage them. Additionally, there was an uneven distribution of textbooks among the students.

The interview with the mathematics subject teacher revealed effective teaching that aligns with the applicable curriculum. However, the students still lack enthusiasm and eagerness in responding to the material being taught by the teacher. One of the reasons mathematics is difficult for students to understand is the lack of teaching materials. The teacher also mentioned that students never receive additional teaching materials, such as modules, in their learning activities. One such topic is Systems of Linear Equations in Two Variables, which is taught in the eighth grade. Students frequently encounter considerable challenges in resolving Systems of Linear Equations in Two Variables. Moreover, students encounter difficulties in resolving issues associated with real-life scenarios relevant to this subject matter (Farida et al., 2022).

METHOD

This study uses development research as its methodology. This research employs the 4-D model (Four D models) as its development model. As the name suggests, the 4-D model consists of 4 stages: (1) define, (2) design, (3) develop, and (4) disseminate (Thiagarajan, S., Semmel, 1974). The trial involved developing a module using a realistic mathematics education approach for eighth-grade students, specifically focusing on systems of linear equations in two variables. The subjects in this phase are 30 to 40 eighth-grade students, divided into high-ability and medium-ability students at MTsN 1 Central Aceh. The selected expert test consists of two competent individuals in the field of mathematics, namely two mathematics lecturers from IAIN Takengon as subject matter experts and media experts, and one mathematics teacher from the eighth grade of MTsN 1 Central Aceh as a practitioner.

The data collection instruments used in the research are the interview instrument sheet, the module validation sheet, the observation sheet for the implementation of learning by teachers and students, the response questionnaires for teachers and students, and the learning outcome tests. Then the data analysis continued with a descriptive validation questionnaire, which contained questions or statements with answers in the form of acceptance or rejection. The validators obtained the data.

Table 1. Likert Scale Assessment Categories

No.	Score	Description
1	Score 4	Fully Agreed
2	Score 3	Agree
3	Score 2	Disagree
4	Score 1	Strongly Disagree

Aiken's V validity test. Aiken developed the Aiken's V formula, which determines the content-validity coefficient by analyzing the evaluations of a panel of n experts on an item's representation of the construct under study.

Table 2. Interpretation of Product Validation Questionnaire Scores

Score	Eligibility
0,81 – 1,00	Very Valid
0,61 – 0,80	Valid
0,41 – 0,60	Less Valid
0 – 0,40	Invalid

If the validation results show a score > 0.61 for each item, then the development media is declared valid, and no revisions are required for the media that will be tested. Students' feedback from the student response survey provides data, which we analyze to assess the module's feasibility. We do this by applying a realistic mathematics approach to the topic of systems of linear equations in two variables, which we are currently developing. We analyze the responses from teachers and students using a Likert scale, adhering to the assessment guidelines outlined in the table below.

Table 3. Guidelines for Assessing Teacher and Student Response Surveys

Scale	Description
1	Strongly Disagree
2	Disagree
3	Agree
4	Fully Agreed

We use the results of the analysis of the student response questionnaire to ascertain the positive reactions of the students to the developed media, interpreting the scores accordingly.

Table 4. Guidelines for Scoring the Teacher and Student Response Questionnaire

Percentage (%)	Eligibility
81 – 100	Very interesting.
61 – 80	Interesting
41 – 60	Less Interesting
0 – 40	Not Interesting at All

If the validation results show a percentage $> 61\%$ for each aspect, then the developed media is considered to have received a positive response from the students. Therefore, the media that has been developed is deemed suitable for use as a learning medium to support educational activities.

The analysis of student test results is conducted using the students' test scores to assess the practicality of the developed learning media. The students' test results are assessed based on the scoring guidelines. The maximum score for this test is 100. The completion criteria use the Minimum Completion Criteria (KKM) applied by the junior high school that is the subject of the research. The analysis was conducted in the following stages: 1) Tabulation of test results data; 2) Converting student test data with the guideline table into learning outcomes.

Table 5. Guidelines for Analyzing Student Test Results

Percentage of Student Completion (%)	Effectiveness
$x > 80$	Very Good
$60 < x \leq 80$	Good
$40 < x \leq 60$	Good Enough
$20 < x \leq 40$	Not Good
$x \leq 20$	Very Not Enough

Student test results are considered practical if they reach a minimum completeness percentage, while they are considered very good if they achieve a completeness percentage of $x > 80$.

RESULT AND DISCUSSION

Definition Stage

Examination of the front end of

The analysis was conducted at the school to produce the required teaching materials. According to the findings of the observations conducted at MTsN 1 Central Aceh, it was discovered that a significant number of students face challenges in comprehending mathematical concepts and struggle to retain them. Additionally, many students exhibit low levels of engagement in mathematics due to feelings of boredom. Based on an interview with a teacher at MTsN 1 Central Aceh, the following information was obtained: (1) The curriculum utilized is Curriculum 2013, (2) Teachers use books published by Kemdikbud, along with other supplementary books and Students' Work Sheets, ensuring that they are not limited to a single book, (3) Students use package books from Kemdikbud, but the available package books are insufficient for all students. Based on the findings from observations and interviews, it is imperative to create a learning module that incorporates the RME approach and focuses on solving two-variable linear equation systems. The technique was selected to facilitate the acquisition of students' knowledge, enhance comprehension of mathematical issues, and provide teachers with knowledge and instructional materials in the form of modules.

Analysis by students

The results of the observations show that the government does provide pupils with mathematical textbooks, but they struggle to understand them and no instructional strategy is implemented.

Analysis of concepts

The goal of this exercise is to find challenging content that would work well in the learning module and to include it into the curriculum. One of the math instructors at MTsN 1 Central Aceh, Mrs. Zuhruf, S.Pd., revealed during their conversation that she had never developed a mathematical module using a RME technique to enhance learning.

Analysis of Tasks

Preliminary proficiency assessment is conducted prior to disseminating learning indicators in task analysis. The study's authors analyzed the critical activities that pupils were required to complete with a bare minimum of skill.

Formula for Learning Purpose

Based on the front-end analysis's findings. The research subsequently develops the instructional materials to be integrated into the module content. The following are the learning objectives: The content of the Two-Variable Linear Equation System is comprehensible to pupils. Students can resolve problems involving systems of two-variable linear equations through graphical methods. 3) Through the subtitling method, students may identify the problem and resolve a system of two-variable linear equations. Students can solve systems of linear equations with two variables using the mixed strategy of elimination and substitution. Students will demonstrate proficiency in constructing a problem model for a system of two-variable linear equations. Students successfully addressed problems related to a real-world linear system with two variables.

Design Stage

Upon the conclusion of the designating phase, the subsequent phase is the planning phase, which is also referred to as design. Some of the duties that are involved in the design phase of the product development module include:

Selection of media

By evaluating objectives and concepts, as well as the school's facilities and the characteristics of the students, the selection of media is determined. The module that was chosen is designed to enhance the learning process in both the classroom and independently. The module that has been devised employs a practical approach to mathematical education. For this reason, even if the module's teaching materials are still relevant today, MTsN 1 Central Aceh has not yet developed them.

Format selection

The adaptation of fundamental and basic competencies, as well as curricula based on the K13 curriculum, is a component of the preparation process for the product design of this module. The RME approach is the foundation for the development of the mathematics learning module, which applies a realistic mathematical education paradigm. The researchers limited the content in this module to the system of two-variable linear equations. The module was designed in alignment with the principles of the RME approach, encompassing context utilization, progressive mathematical models, student-generated outcomes, interactivity, and connectivity.

Initial Design

This module is comprised of the cover, the beginning of the module consists of an introductory word, a list of contents, a glossary, a concept map, and a module introduction. The module contents consist of a description of the learning contents of the linear equation system of two variables, a summary, as well as the evaluation that is used to determine the level of learning results of the student. Researchers utilize realistic mathematical education as a foundation in the production of materials; students can also acquire knowledge about the practical application of these materials in their daily lives.

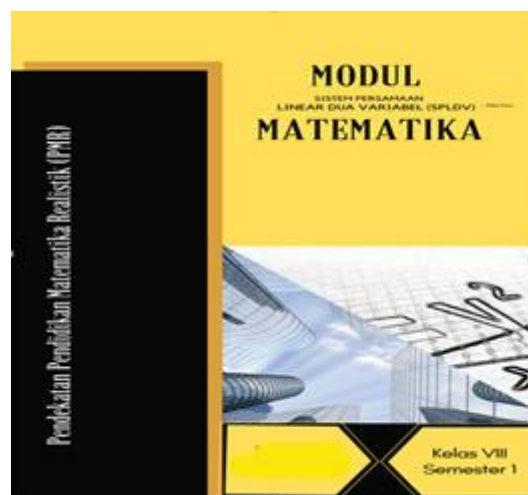


Figure 1: Cover of Module

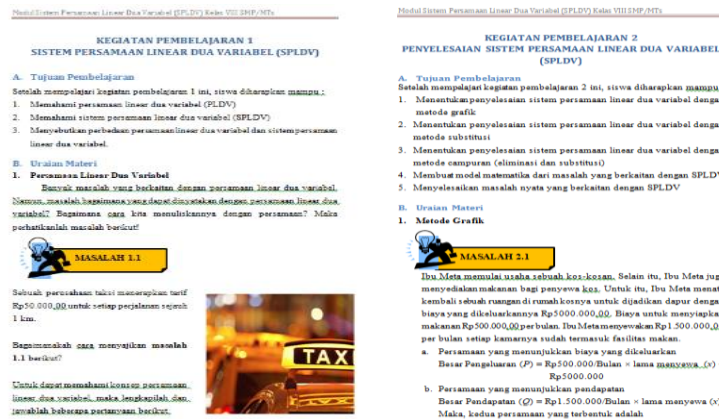


Figure 2. Description of the Learning Module Content

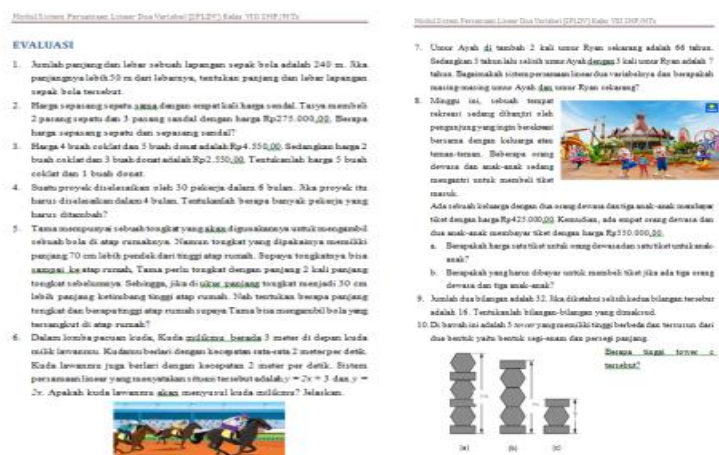


Figure 3. Evaluation

Development Stage

The following phase of development entails the development of a product that has already been conceptualized during the design phase. The process commences with the amalgamation of a module structure, encompassing the module cover, the material (fill), and the close, all of which are generated utilizing the Microsoft Word application. The cover module is the opening portion of the module, which has been adapted to the linear equation system material of two variables, as well as the self-identity column. The introductory words, the glossary, the concept map, the list of contents, and the introduction comprise the initial portion of the modulus. The modulus comprises a summary, a description of the learning contents for the two-variable linear system of equations, and evaluation issues that are employed to ascertain the level of learners' learning outcomes. Following the module's completion, we proceed to the validation stage, during which we evaluate and validate the module to guarantee its relevance to the student. The validator performs this evaluation to collect feedback and recommendations for improving the produced module.

Additional activities are implemented during this phase, including the examination of the outcomes of the field trials. The assessment will focus on the efficacy of the educational media, encompassing the implementation of the instructional framework, the feedback from educators, and the reactions of learners to the generated modules.

The mathematics module, which employs a realistic mathematical education approach to the linear equation system of two variables, was validated by two experts

from distinct disciplines, specifically materialists and media experts. Aiken's V functions as the validity test. The material underwent validation by two validators, who obtained results in the following areas: content validity, presentation validity, language validity, and RME assessment. The criteria were either very excellent or very valid, as indicated by the material expert's presentation of the evaluation scores for the four aspects.

Table 7. Validation Results by Subject Matter Experts

Aspect	Average	Description
Content Eligibility	0.899	Very Valid
Presentation Eligibility	0,883	Very Valid
Assessment of Realistic Mathematics Education Approach	0,90	Very Valid

Table 8. Validation Results by Media Experts

Aspect	Average	Description
Content Eligibility	0.833	Very Valid
Module Cover Design	0,899	Very Valid
Module Content Design	0,962	Very Valid

The test results concerning the implementation of the learning syntax indicated that the average performance in the high ability class was 93.22% and in the intermediate ability class was 92.18%. The learning syntax proved effectiveness based on the criteria of implementation. Student engagement in the learning process for the advanced class and the intermediate class surpassed the 75% barrier, with averages of 86.60% and 75.89%, respectively. This indicates that the student's activity was functioning efficiently.

The examination of student responses to the learning module yielded positive results, with an average response rate of 86.53% in the high ability class and 87.66% in the moderate skill class. By normalizing the test results of students to a minimal standard score of 70, we observe that all pupils' test outcomes surpass the average score of 70, indicating that they have all successfully passed the test. Based on the results of the analysis, the learning module with the Indonesian Realistic Mathematics Education (PMRI) approach in Clas VIII MTsN 1 Central Aceh has met the appropriate criteria, namely valid and practical.

Dissemination Stage

Researchers' dissemination of their findings is restricted by their constraints. The researchers distribute the product of this teaching material to three schools, namely SMP IT Cendekia Takengon, SMP IT Al-Azhar Takengon, and SMP IT Az-Zahra Takengon, and distribute it in PDF format via schools' email.

The findings indicate that utilizing the teacher's and students' books on systems of linear equations in two variables, grounded on realistic mathematical education (RME), is uncomplicated when adhering to the established protocols. This aligns with the research findings of (Sepriyanti & Putri, 2018), which suggest that an RME-based probability learning design can improve students' reasoning skills and enable them to recognize mathematics in a realistic manner.

Other research findings also indicate that the learning pathway that adheres to the principles of the RME approach emphasizes informal problem solving in this learning trajectory (Fauzan & Diana, 2020). We leverage the prior knowledge and experiences students have gained in their lives.

CONCLUSION

The Thiagarajan development model, referred to as 4-D. According to expert evaluation, the produced module satisfies both validity and practicality criteria based on syntax analysis, student engagement analysis, student feedback, teacher feedback, and learning outcome assessments. The module employed in this study to instruct eighth-grade students at MTsN 1 Central Aceh on systems of linear equations in two variables in a realistic manner fulfilled two criteria: it is valid and beneficial. It is essential to broadly implement a realistic mathematics education method to enhance social learning, as it evidences students' satisfaction and fosters greater engagement in the learning process. The produced module exclusively addresses systems of linear equations in two variables, suggesting the possibility of future modules including broader subjects.

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