

DEVELOPMENT OF CONTEXTUAL-BASED MATHEMATICS TEACHING MATERIALS TO FACILITATE STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY ON SYSTEMS OF LINEAR INEQUALITIES IN TWO VARIABLES

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ABSTRACT This study was motivated by students' low mathematical problem-solving ability, particularly in solving contextual problems related to systems of linear inequalities in two variables. Students often experience difficulties in understanding problems, constructing mathematical models, drawing graphs, and determining the solution region because learning materials tend to emphasize procedural exercises rather than systematic problem-solving stages. This study aims to develop contextual-based mathematics teaching materials on systems of linear inequalities in two variables to facilitate Phase E students' mathematical problem-solving ability. This research employed a Research and Development (R&D) design using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. The developed product was validated by three mathematics education experts and tested through one-to-one evaluation, a small group trial involving six students, and a field test involving 35 students. The instruments used were validation sheets and student response questionnaires. The validation results showed an average score of 95.27%, categorized as very valid. The practicality test obtained an average score of 89.16% in the small group trial and 92.96% in the field test, both categorized as very practical. These findings indicate that the contextual-based mathematics teaching materials are valid and practical for use in learning systems of linear inequalities in two variables and can serve as an alternative teaching material to facilitate students' mathematical problem-solving ability.

Keywords: contextual approach, mathematical problem-solving ability, systems of linear inequalities in two variables, teaching materials, validity and practicality

ABSTRAK Penelitian ini dilatarbelakangi oleh rendahnya kemampuan pemecahan masalah matematis siswa, khususnya dalam menyelesaikan masalah kontekstual pada materi sistem pertidaksamaan linear dua variabel. Siswa sering mengalami kesulitan dalam memahami masalah, menyusun model matematika, menggambar grafik, dan menentukan daerah himpunan penyelesaian karena bahan ajar yang digunakan cenderung menekankan latihan

prosedural daripada tahapan pemecahan masalah secara sistematis. Penelitian ini bertujuan untuk mengembangkan bahan ajar matematika berbasis pendekatan kontekstual pada materi sistem pertidaksamaan linear dua variabel untuk memfasilitasi kemampuan pemecahan masalah matematis siswa Fase E. Penelitian ini menggunakan desain *Research and Development* (R&D) dengan model ADDIE yang terdiri atas tahap analisis, desain, pengembangan, implementasi, dan evaluasi. Produk yang dikembangkan divalidasi oleh tiga ahli pendidikan matematika dan diuji melalui *one-to-one evaluation*, uji kelompok kecil yang melibatkan enam siswa, serta uji lapangan yang melibatkan 35 siswa. Instrumen yang digunakan berupa lembar validasi dan angket respons siswa. Hasil validasi menunjukkan rata-rata skor sebesar 95,27% dengan kategori sangat valid. Hasil uji praktikalitas memperoleh rata-rata skor sebesar 89,16% pada uji kelompok kecil dan 92,96% pada uji lapangan, keduanya termasuk kategori sangat praktis. Temuan ini menunjukkan bahwa bahan ajar matematika berbasis pendekatan kontekstual valid dan praktis digunakan dalam pembelajaran sistem pertidaksamaan linear dua variabel serta dapat menjadi alternatif bahan ajar untuk memfasilitasi kemampuan pemecahan masalah matematis siswa.

Kata-kata kunci: bahan ajar, kemampuan pemecahan masalah matematis, pendekatan kontekstual, sistem pertidaksamaan linear dua variabel, validitas dan praktikalitas

INTRODUCTION

Problem-solving ability is an essential skill that every individual should possess because daily life often presents various problems that require accurate and appropriate solutions. Therefore, developing students' mathematical problem-solving ability is one of the main goals of mathematics learning and is in line with the demands of 21st-century competencies that emphasize problem-solving skills (Hendriana et al., 2021; Khairi et al., 2024). However, various studies show that students' mathematical problem-solving ability remains low. The 2022 PISA results showed that the average mathematics score of Indonesian students was 366, which was still below the OECD average of 465–475 (Kemendikbudristek, 2023). Rachmawati and Adirakasiwi (2021) found that students were still weak in the stage of understanding problems, while Damayanti and Kartini (2022) reported that only 15.70% of students rechecked their calculation results. Azizah et al. (2024) also showed low achievement across all problem-solving indicators, particularly in understanding problems (25.6%) and checking results (7%).

The need for specially designed teaching materials is further supported by empirical evidence from the preliminary analysis conducted by the researcher at school. Interviews with mathematics teachers revealed that students experienced significant difficulties in translating contextual descriptions into mathematical symbols, particularly in determining the solution region of a system of inequalities. Students' low mathematical problem-solving ability is also related to the learning process, which has not optimally trained students through systematic problem-solving stages. Learning is still dominated by the delivery of formulas and procedures, as well as routine exercises, so students have limited meaningful learning experiences in understanding and solving problems systematically (Jayanti et al., 2019).

This problem is particularly evident in the topic of systems of linear inequalities in two variables. This topic requires students to understand complex problem situations, construct mathematical models, draw graphs, and determine the solution region. However, learning in schools still tends to be formula-based and procedural (Astuti et al., 2019; Muchsin et al., 2019). The contextual approach is known to support students in solving mathematical problems because it connects mathematical concepts with real-life situations (Arafani et al., 2019; Rahim & Wahyuni, 2019). Nevertheless, existing teaching materials generally still focus on routine exercises and do not fully facilitate students through the stages of problem solving (Kharisma & Sugiman, 2020; Muliwana et al., 2023).

The novelty of this study lies in the systematic integration of the six components of the contextual approach, namely constructivism, inquiry, questioning, modeling, reflection, and authentic assessment, into mathematics teaching materials designed specifically for Phase E students in the Kurikulum Merdeka. Unlike generic teaching materials, the product developed in this study provides a structured bridge between real-world problems identified in the school context and the mathematical problem-solving indicators needed in the topic of systems of linear inequalities in two variables. Developing these teaching materials is important because contextual materials can make mathematical topics more relevant to students' environments and broaden their understanding (Yuherni et al., 2020). To ensure this product is truly a solution, the developed teaching materials must meet basic eligibility criteria, namely validity and practicality (Kharisma & Sugiman, 2020; Anjarsari, et al., 2022).

Based on this background, this study aims to develop and evaluate the validity and practicality of contextual-based mathematics teaching materials on the topic of systems of linear inequalities in two variables to facilitate the mathematical problem-solving ability of Phase E students.

METHODS

This study employed a Research and Development (R&D) method using the ADDIE model, which consists of five integrated stages: Analysis, Design, Development, Implementation, and Evaluation (Dick & Carey, as cited in Rusmayana, 2021). The scope of this study was specifically focused on evaluating the validity and practicality of the developed teaching materials. The product developed in this study was contextual-based mathematics teaching materials on the topic of systems of linear inequalities in two variables to facilitate students' mathematical problem-solving ability.

The analysis stage was conducted through three main activities. First, a needs analysis was carried out through semi-structured interviews with mathematics teachers to identify learning difficulties and obstacles faced by students. Second, a curriculum analysis was conducted by examining the Learning Outcomes (*Capaian Pembelajaran*) for Phase E based on BSKAP No. 046 of 2025. Third, a student analysis

was conducted to determine students' cognitive characteristics and contextual situations that were relevant to Grade 10 students in Pekanbaru.

The design stage was carried out by preparing the instructional framework of the teaching materials. At this stage, the six components of the contextual approach, namely constructivism, inquiry, questioning, modeling, reflection, and authentic assessment, were integrated into learning activities designed to facilitate students' mathematical problem-solving ability. The teaching materials were structured to guide students in understanding contextual problems, constructing mathematical models, solving problems, and interpreting the results.

The development stage involved realizing the teaching materials according to the design and conducting expert validation. The developed teaching materials were validated by three expert lecturers in mathematics education to assess their pedagogical and content suitability. The validation process covered several aspects, including graphical design, language, content, presentation feasibility, the suitability of the teaching materials with the components of the contextual approach, and the suitability of the teaching materials with indicators of mathematical problem-solving ability.

The implementation stage was conducted to examine the practicality of the developed teaching materials. The implementation process involved one-to-one evaluation, a small group trial involving six students, and a field test involving 35 students with heterogeneous abilities. The main purpose of this stage was to measure the practicality of the teaching materials through student response questionnaires. During this stage, the researcher acted as a facilitator and observer in the process of using the teaching materials.

The evaluation stage consisted of formative and summative evaluations. Formative evaluation was conducted at the end of each ADDIE stage to revise and improve the product based on expert suggestions and student feedback. Summative evaluation was conducted at the end of the development process to analyze the validity and practicality data and to determine whether the final product met the criteria of being valid and practical.

The research instruments consisted of validation sheets and student response questionnaires. The validation sheets were used to assess graphical design, language, content, presentation, contextual approach components, and mathematical problem-solving indicators using a Likert scale. The student response questionnaires were used to assess the practicality of the teaching materials, including ease of use, material delivery, and the suitability of the teaching materials with students' needs, interests, and conditions.

Quantitative data were analyzed by calculating the average percentage of the scores, which were then interpreted using a five-level categorization scale adapted from Riduwan (2018). The categories were as follows: very valid/practical (81%–100%), valid/practical (61%–80%), fairly valid/practical (41%–60%), less

valid/practical (21%–40%), and invalid/not practical (0%–20%). The teaching materials were declared feasible for implementation if they reached at least the valid and practical categories. Qualitative data obtained from validator comments and student feedback were analyzed through data reduction, data display, and conclusion drawing to support the systematic revision of the teaching materials.

FINDING AND DISCUSSION

At the analysis stage, the results showed that the mathematics teaching materials used in the school still had several limitations in facilitating students' mathematical problem-solving ability. Students still had difficulty understanding the context of problems, constructing mathematical models, drawing graphs, and determining the solution region. This occurred because the teaching materials did not present problem-solving stages systematically and were not sufficiently contextual.

The material development referred to the Kurikulum Merdeka for Phase E, as stated in BSKAP No. 046 of 2025. The learning outcome for the topic of systems of linear inequalities in two variables states that by the end of Phase E, students are expected to be able to solve problems related to systems of linear inequalities in two variables. Based on this learning outcome, a concept map was developed, as presented in Figure 1.

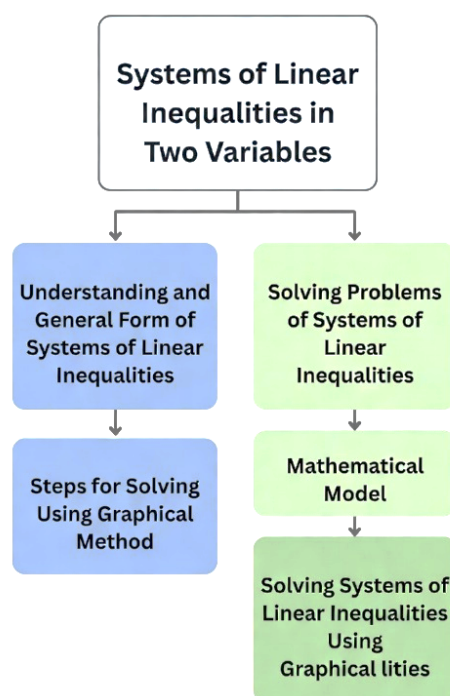


Figure 1. Concept Map of Systems of Linear Inequalities in Two Variables

The topic of systems of linear inequalities in two variables was divided into three learning activities: (1) mathematical models of systems of linear inequalities in two variables from contextual problems; (2) graphs and solution regions of systems of

linear inequalities in two variables; and (3) solutions and interpretation of results from contextual problems involving systems of linear inequalities in two variables.

At the design stage, the teaching materials were systematically planned by integrating a contextual approach to facilitate students' mathematical problem-solving ability. The teaching materials were organized into three main sections: introduction, content, and conclusion. The structure of the teaching materials is presented in Table 1.

Table 1. Structure of the Teaching Materials

Teaching Material Section	Component Elements
Introduction Section	<ol style="list-style-type: none"> 1. Foreword 2. Table of contents 3. Teaching material description 4. Instructions for using the teaching materials 5. Concept map 6. General overview
Content Section	<ol style="list-style-type: none"> 1. Cover page for each learning activity, including subtopics and learning objectives 2. Learning activities, including components of the contextual approach
Conclusion Section	<ol style="list-style-type: none"> 1. Competency test 2. Reflection 3. Glossary 4. Bibliography 5. Author profile

The design of the teaching materials explicitly integrated the six components of the contextual approach, namely constructivism, inquiry, questioning, modeling, reflection, and authentic assessment. These components were included to ensure that each learning activity could guide students through the stages of mathematical problem solving. In addition, research instruments were also designed at this stage, including validation sheets for experts and student response questionnaires. The validation sheets covered graphical aspects, language, content, presentation feasibility, the suitability of the teaching materials with the contextual approach components, and the suitability of the teaching materials with mathematical problem-solving indicators. Meanwhile, the student response questionnaire was designed to measure practicality, including ease of use, material delivery, and the suitability of the teaching materials with students' needs, interests, and conditions. At the development stage, the teaching materials were realized based on the design. The cover appearance of the teaching materials is presented in Figure 2.



Figure 2. Display of the Teaching Material Cover

The teaching materials were then validated by three mathematics education lecturers. The validation results are presented in Table 2.

Table 2. Validation Results of the Teaching Materials

Aspects Evaluated	Validator 1	Validator 2	Validator 3	Average (%)
Graphical aspect	100.00	84.38	96.88	93.75
Language	100.00	81.25	93.75	91.67
Content suitability	100.00	93.75	97.00	96.91
Presentation suitability	100.00	90.00	95.00	95.00
Suitability with contextual approach components	100.00	92.75	96.50	96.41
Suitability with mathematical problem-solving indicators	100.00	93.75	100.00	97.92
Average (%)	100.00	89.31	96.50	95.27

Based on Table 2, the average validation score of the teaching materials was 95.27%, which is categorized as very valid. The highest score was obtained in the aspect of suitability with mathematical problem-solving indicators, with an average of 97.92%, followed by suitability with contextual approach components, with an average of 96.41%. These results indicate that the developed teaching materials are appropriate in terms of content, presentation, language, visual design, contextual approach components, and mathematical problem-solving indicators.

The high validation score also shows that the teaching materials were conceptually aligned with the intended learning objectives. For example, the modeling component was designed to help students translate contextual problems into mathematical inequalities, which had been identified as one of the main difficulties during the analysis stage. Thus, the teaching materials do not only present routine exercises, but also guide students to understand the problem context, construct mathematical models, and interpret solutions.

Based on the validators' suggestions, several revisions were made to improve the quality of the teaching materials. The revisions included improving terminology, clarifying examples, adjusting illustration sizes, and ensuring consistency in mathematical symbols. One validator suggested replacing the checkmark symbol used for solution alternatives with the word "meets" because the meaning of the symbol had not been explained previously.

After expert validation, a one-to-one evaluation was conducted with three students who had different ability levels. The students stated that the teaching materials were easy to understand. However, they suggested that the instructions should be made clearer and that the steps for completion should be presented more explicitly. These suggestions were used as the basis for revising the teaching materials before proceeding to the implementation stage.

The implementation stage began with a small group trial involving six students with heterogeneous abilities. At this stage, students showed enthusiasm in understanding contextual problems, although some of them still needed guidance, particularly in determining variables and constructing mathematical models. After the students finished using the teaching materials, the researcher distributed a response questionnaire to measure the practicality of the product. The results of the response questionnaire in the small group trial are presented in Table 3.

Table 3. Results of the Response Questionnaire in the Small Group Trial

Aspect Assessed	Average (%)	Category
Ease of use	95.00	Very practical
Material delivery	88.10	Very practical
Relevance of teaching materials to students' needs, interests, and conditions	84.38	Very practical

Aspect Assessed	Average (%)	Category
Average	89.16	Very practical

Based on Table 3, the results of the response questionnaire in the small group trial showed an average practicality score of 89.16%, which is categorized as very practical. The highest score was obtained in the aspect of ease of use, with 95.00%. This indicates that students were able to use the teaching materials easily and that the structure of the materials helped them follow the learning activities.

After the small group trial, the product was tested on a wider scale through a field test involving 35 students. The results of the response questionnaire in the field test are presented in Table 4.

Table 4. Results of the Response Questionnaire in the Field Test

Aspect Assessed	Average (%)	Category
Ease of use	94.57	Very practical
Material delivery	91.63	Very practical
Relevance of teaching materials to students' needs, interests, and conditions	92.68	Very practical
Average	92.96	Very practical

Based on Table 4, the results of the response questionnaire in the field test showed an average practicality score of 92.96%, which is categorized as very practical. This score confirms that the developed teaching materials are easy to use and that the material delivery supports the learning process on systems of linear inequalities in two variables. The practicality results in both the small group trial and the field test show consistent findings, with scores of 89.16% and 92.96%, respectively.

The practicality test also showed that the structured scaffolding in the teaching materials helped students move from understanding the problem to checking their results. These stages are often skipped in routine learning. Through contextual activities, students were guided to identify information in the problem, determine variables, construct mathematical models, represent inequalities graphically, determine the solution region, and interpret the results in relation to the original context.

The teaching materials support mathematical problem-solving ability through the integration of contextual teaching and learning components. First, the constructivism component helps students understand the problem by connecting new concepts with prior knowledge and real-life situations. Each learning activity

begins with a contextual problem that is close to students' daily experiences, allowing students to identify known and unknown information more meaningfully. Second, the inquiry and modeling components guide students in planning and carrying out solutions. The teaching materials provide structured prompts that lead students to determine variables, build mathematical models, and represent the solution graphically. During the implementation stage, students were able to follow the process of determining the solution region more systematically because the materials connected graphical representation with actual constraints in contextual problems.

Third, the reflection component helps students look back at their solutions. The teaching materials include reflection activities that require students to interpret their mathematical findings in relation to the original context. This component addresses a common weakness in students' mathematical problem solving, where students may obtain a numerical or graphical solution but are unable to explain its meaning in real-world situations.

Formative evaluation was conducted at each stage of the ADDIE model, including revisions based on expert validation and student feedback. The summative evaluation showed that the teaching materials had met the two main criteria of being very valid and very practical. The evaluation process also showed that integrating contextual approach components helped guide students in understanding the problem context and following mathematical problem-solving indicators.

The research results indicate that the contextual-based teaching materials developed through the ADDIE stages have met the criteria for validity and practicality. The average expert validation score of 95.27% shows that the product is conceptually appropriate, particularly in integrating contextual approach components to guide students through problem-solving stages. This finding is important because teaching materials should not only present mathematical content, but also provide learning activities that help students understand contextual problems and construct mathematical models.

The main contribution of this product lies in its structured scaffolding, which addresses the learning difficulties identified during the analysis stage. Existing materials often focus on routine exercises, whereas this product is designed to mediate the transition from informal real-world contexts to formal mathematical modeling in systems of linear inequalities in two variables. This is in line with Kharisma and Sugiman (2020), who emphasized that teaching materials should move beyond routine drills in order to support meaningful mathematical learning.

Furthermore, the teaching materials provide contextual situations that make abstract inequalities more relatable to Phase E students. By connecting the topic to daily experiences, the product is expected to facilitate students' conceptual engagement. This is consistent with Yuherni et al. (2020), who stated that contextual

topics can broaden students' understanding by connecting mathematics to their immediate environment. During the trials, students were able to follow the systematic process of identifying information, constructing mathematical models, and interpreting graphical solutions within the provided contexts.

It is important to emphasize that this study was limited to assessing the validity and practicality of the developed teaching materials. Although the implementation trials yielded positive student responses and high practicality scores, these findings do not constitute formal evidence of improved student learning outcomes. The qualitative evidence suggests that the materials facilitated problem-solving indicators during trial sessions; however, claims regarding their effectiveness must be tested through further experimental research. Consistent with the principles of research and development (R&D) using the ADDIE model, proving validity and practicality is a fundamental prerequisite before any claims regarding the impact on learning outcomes can be established through subsequent effectiveness testing.

Overall, the evaluation results confirm that the developed contextual-based mathematics teaching materials are feasible for use in learning systems of linear inequalities in two variables. By integrating contextual approach components into a systematic module, this research provides teaching materials that are conceptually designed to support students in navigating contextual problem-solving processes.

CONCLUSIONS AND RECOMMENDATIONS

This development research produced contextual-based mathematics teaching materials on systems of linear inequalities in two variables to facilitate Phase E students' mathematical problem-solving ability. The developed teaching materials were declared very valid based on expert validation, with an average score of 95.27%. The practicality test also showed very practical results, with an average score of 89.16% in the small group trial and 92.96% in the field test. These findings indicate that the teaching materials are feasible for use in mathematics learning because they are appropriate in terms of content, language, presentation, graphical design, contextual approach components, and mathematical problem-solving indicators. The integration of contextual learning components also provides structured guidance for students in understanding contextual problems, constructing mathematical models, determining solution regions, and interpreting results.

Based on these findings, the developed teaching materials can be used by mathematics teachers as an alternative learning resource to support contextual and problem-solving-oriented learning, especially on systems of linear inequalities in two variables. Teachers are encouraged to use these materials to help students connect mathematical concepts with real-life situations and follow problem-solving stages more systematically. However, this study was limited to validity and practicality testing; therefore, further research is recommended to examine the effectiveness of the teaching materials through experimental studies. Future development may

also expand the contextual problems to different topics, school contexts, and student characteristics to improve the adaptability and broader use of the product.

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