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A Praxeological Analysis of Textbook: Systems of Linear Inequalities in Two Variables

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ABSTRACT

This study aims to analyse the presentation of systems of linear inequalities in two variables in Grade X senior high school/vocational high school mathematics textbooks under the Merdeka Curriculum using a praxeological framework. This research employed a qualitative method through document analysis of the student textbook and teacher guidebook published in the 2023 revised edition. The data were analysed based on the four components of praxeology: task, technique, technology, and theory. The findings show that the textbook presents contextual and exploratory tasks that encourage students to construct mathematical models from real-life situations. However, the continuity between exploratory tasks and procedural exercises is not consistently developed. In terms of technique, students are mostly directed to use graphical methods, while alternative strategies such as numerical testing or algebraic approaches are not sufficiently explored. The technology component, which refers to the justification of techniques, is not explicitly emphasised. Similarly, the theory component is not clearly presented in the student textbook, leaving formal mathematical concepts implicit. These findings indicate that the textbook has not fully supported students' conceptual understanding of systems of linear inequalities in two variables. Therefore, teachers play an important role in complementing, contextualising, and deepening the material presented in the textbook.

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1. INTRODUCTION

Mathematics is a compulsory subject taught at various levels of education, from elementary school to senior high school. One of the important topics in senior high school mathematics is the system of linear inequalities in two variables. This topic is intended to help students model real-life problems into mathematical forms and determine the set of possible solutions. Therefore, students are expected not only to perform procedures but

also to understand the meaning of inequalities and their applications in contextual situations.

The system of linear inequalities in two variables is essential because it is closely related to everyday problems, such as optimisation, cost constraints, time limitations, and decision-making situations [1]. Equations and inequalities are also part of mathematical literacy, as they train students to think quantitatively and apply mathematical concepts in real contexts [2]. In addition, this topic serves as a foundation for more advanced materials, such as optimisation and linear programming [3]. Thus, learning this topic is important for connecting abstract mathematical concepts with problems that students may encounter in daily life.

To support students' understanding of this topic, learning resources are important. Textbooks are one of the most widely used learning resources in mathematics classrooms [4]. Previous studies have shown that teachers often rely on textbooks as the main reference for explaining concepts, providing examples, and assigning exercises [5], [6]. Textbooks are not only instructional materials but also tools that shape classroom activities, students' mathematical thinking, and teachers' pedagogical decisions [7], [8], [9]. In the Indonesian context, the government has provided textbooks for students and teachers as official learning resources since the implementation of the 2013 Curriculum [10]. Therefore, the quality of textbook content and presentation needs careful attention.

Although textbooks are available as learning resources, students still struggle to understand and solve problems involving systems of linear inequalities in two variables. Previous studies have reported several student errors, including misinterpreting inequality signs, using inappropriate formulas, and making procedural and technical mistakes [11]. These difficulties are often caused by a lack of prerequisite knowledge, carelessness in numerical operations, and misconceptions about inequality symbols [12], [13], [14]. Such findings indicate that students' difficulties are not only related to their individual abilities but may also be connected to how the material is presented in learning resources.

Several studies suggest that misconceptions may arise when textbooks emphasise procedures without providing sufficient contextual and conceptual foundations [12]. Exercises that are not adequately connected to real-world contexts may limit students' opportunities to construct meaningful understanding. In addition, textbooks that present material directly without considering students' thinking stages may create learning obstacles [15]. This condition is not fully aligned with the Merdeka Curriculum, which emphasises contextual learning and mastery of competencies. Therefore, analysing the presentation of mathematical content in textbooks is necessary to determine whether they support conceptual understanding or encourage procedural learning.

Previous textbook analyses have generally focused on conceptual accuracy, cognitive levels based on Bloom's taxonomy, and mathematical literacy [16], [17], [7]. Although these studies provide valuable insights, they tend to focus on the types of content or tasks presented in textbooks. They do not sufficiently examine the mathematical knowledge embedded in the tasks, the techniques expected to solve them, and the justifications that support those techniques [18]. This creates a need for a more

comprehensive analytical approach to understand how mathematical concepts are structured and presented in textbooks.

Praxeology theory provides a relevant framework for analysing textbook content. In praxeology, mathematical activity is examined through four components: task, technique, technology, and theory [19]. This framework allows researchers to investigate not only the types of tasks given to students but also how students are expected to solve them, the reasoning that supports the techniques, and the formal mathematical concepts underlying the learning process. Previous studies have shown that praxeological analysis can provide insights into the strengths and limitations of learning materials and their potential contribution to classroom instruction [22], [23].

Based on the above explanation, this study aims to analyse the presentation of the system of linear inequalities in two variables in Grade X mathematics textbooks under the Merdeka Curriculum using a praxeological framework. Specifically, this study examines how the textbook presents tasks, techniques, technology, and theory in relation to the topic. The findings are expected to inform teachers in selecting, modifying, and enriching learning materials, as well as textbook authors in developing more effective mathematics textbooks.

2. METHOD

This study employed a qualitative research design using a praxeological framework. The qualitative approach was chosen because this study aimed to describe and interpret how the topic of systems of linear inequalities in two variables is structured and presented in mathematics textbooks. The analysis focused on identifying the types of mathematical activities in the textbook and the extent to which they support students' conceptual understanding.

The objects of this study were the Grade X mathematics textbooks for SMA/MA/SMK/MAK under the Merdeka Curriculum, published by the Ministry of Education, Culture, Research, and Technology in the 2023 revised edition. The analysed textbooks consisted of the student textbook and the teacher guidebook [24], [25]. These books were selected because they are official textbooks used as references in mathematics learning at the senior high school level in Indonesia.

The scope of the analysis was limited to the subchapter discussing systems of linear inequalities in two variables. This limitation was applied to ensure a focused and in-depth analysis of how the topic is introduced, developed, and supported through examples, exploratory activities, discussions, technology-based activities, and exercises.

The data were collected through document review. The relevant sections of the student textbook and teacher guidebook were examined, including learning objectives, exploratory tasks, discussion prompts, critical thinking activities, technology-based activities, examples, exercises, and teacher instructions. These components were then identified and categorised according to the praxeological framework developed by Chevallard, comprising four components: task, technique, technology, and theory [19].

The data analysis was conducted through several stages. First, the tasks related to systems of linear inequalities in two variables were identified from the textbook. Second,

each task was classified according to its characteristics, such as contextual, exploratory, procedural, or verification-based. Third, the techniques expected or suggested for solving each task were analysed. Fourth, the presence of technology, namely explanations or justifications for the techniques used, was examined. Finally, the theory component was analysed by identifying the formal mathematical concepts, definitions, and principles underlying the tasks and techniques. The analysis results were then interpreted to determine the strengths and limitations of the textbook presentation.

3. RESULTS AND DISCUSSION

3.1. Results

Based on the analysed textbook, the expected learning objectives for students are (1) students can create mathematical models of problems related to systems of linear inequalities in two variables, and (2) students can solve systems of linear inequalities in two variables. Content analysis will specifically focus on these two learning objectives. The concept is presented in the subchapter "B. Systems of Linear Inequalities", which contains several sections as shown in Table 1.

Table 1. Sections in the Textbook

Section	Explanation
Let's Explore (Ayo, Bereksplorasi)	In this section, students observe real-world contexts such as fruit scales or National Independence Day and solve problems using guessing strategies, trial and error, or creating their own models.
Let's Discuss (Ayo, Berdiskusi)	Students discuss problem-solving strategies with their peers. The discussion is guided to develop a shared understanding by comparing different approaches.
Let's Think Critically (Ayo, Berpikir Kritis)	In this section, students are challenged to evaluate the steps they have taken to solve a problem and to test the truth of a statement.
Let's Use Technology (Ayo, Menggunakan Teknologi)	Students are allowed to use digital tools such as GeoGebra to draw graphs and compare the results with manual methods.
Let's try (Ayo, Mencoba)	Students are given exercises in the form of procedural and contextual problems.

Then, a praxeological analysis is conducted on the presentation of the sub-material. In this section, we will discuss the findings from the analysis of the student textbook, focusing on Explorations 4.2 and 4.3, which contain the sections "Let's Explore," "Let's Discuss," "Let's Think Critically," "Let's Use Technology," and the Exercise section containing the "Let's Try" section. An analysis of the teacher's guidebook will also be added to examine the author's original intention. The discussion will be presented in the praxeology component.

Praxis Block

Task (T)

In the student textbook, the questions provided to guide students in constructing their knowledge appear in Exploration 4.2, Exploration 4.3, and the Let's Try sections, each containing 4 questions. The total number of questions to be analysed is 6, which will be written as $T_1 - T_6$. The tasks in the subchapters are shown in the following table.

Table 2. Type of Task

Task (T)	Question
T_1	Mr. Eko weighs fruit using a duck scale. Two apples and five oranges weigh less than 1 kg. Six apples and two oranges weigh more than 1 kg. If we assume that each apple weighs the same and each orange weighs the same, how much does each apple weigh? How much does each orange weigh?
T_2	Kiki is the committee member for the National Independence Day celebration in the neighbourhood association. The neighborhood association has Rp500,000.00 that can be used. To hold the competition, Rp20,000.00 per child is needed. The prize for the winner is budgeted at Rp40,000.00 for each type of competition. It is expected that more than 13 children will participate. Determine the possibilities.
T_3	Bonar has two part-time jobs. For delivering goods, Bonar is paid Rp15,000 per hour. For washing dishes at a restaurant, Bonar is paid Rp9,000 per hour. He cannot work more than 10 hours. Bonar needs Rp120,000. How many hours does he have to work for each job? a. Write the mathematical model. b. Is this mathematical model a system of linear inequalities? c. Draw the graph. d. Determine the coordinates of the intersection points. e. Determine the region that satisfies the system of linear inequalities. f. Can Bonar earn the money he needs by working as a delivery driver for 4 hours? g. Can Bonar earn the money he needs by working for 9 hours?
T_4	Nova bought fertiliser and plants for her garden. Nova had Rp100,000. Each bag of fertiliser costs Rp20,000, and each plant costs Rp10,000. Nova wanted to buy at least 5 plants. How many plants and bags of fertiliser could Nova buy?
T_5	Mrs. Dini needs chicken eggs and quail eggs. Chicken eggs cost Rp22,000 per kg, and quail eggs cost Rp30,000 per kg. Mrs. Dini has Rp150,000. Because she is worried that the eggs will break during transport, Mrs. Dini does not want to carry more than 6 kg of eggs. Can Mrs. Dini buy 6 kg of eggs?
T_6	An UMKM produces two types of liquid soap, namely bath soap and hand soap. For every litre of bath soap, the production cost is Rp15,000.00. The production cost of hand soap is Rp10,000.00 per litre. In addition, the factory must incur a fixed cost of Rp500,000.00. The UMKM has a capital of Rp2,500,000. The existing warehouse can hold 150 litres of liquid soap. Bath soap is sold at Rp25,000.00 per litre, and hand soap at Rp20,000.00 per litre. Can they make a profit at these prices? Provide an example of the amount of bath soap and hand soap sold so that their income exceeds their expenses.

In praxeology, the task component refers to the type of task given, including its structure, which supports students in building their knowledge. Based on the analysis of T_1

$-T_6$, the book contains tasks that are quite good in terms of variety and question stages, but some parts still lack continuity and do not explore cognitive understanding in depth.

In T_1, Exploration 4.2 contains contextual tasks that are exploratory and open-ended. Students are asked to guess the weight of apples and oranges based on two pieces of information provided by the scales. This question directs students to think intuitively, without focusing on algebraic forms. The follow-up to this exploration can be seen in the "Let's Think Critically" section, which encourages students to consider other strategies. Students are then asked to reflect on whether several points are included in the result area of the inequalities. This task focuses more on students' ability to create mathematical models and construct systems of linear inequalities in two variables.

Furthermore, in T_2, Exploration 4.3 gives students the context of spending funds for the National Independence Day activity, with limitations on the number of competitions and cash. Similar to the previous task, this task is also an open-ended, exploratory question, but students are gradually guided towards solving the solution set of systems of linear inequalities in two variables. Subtasks include "Let's Discuss", which encourages students to share their solution strategies, then "Let's Think Critically", which asks students to compare answers using different strategies, and finally "Let's Use Technology", which directs students to use GeoGebra to illustrate the inequalities system, thereby expanding the task to include visual representation. Compared to T_1, this assignment presents a more complete series of tasks, from exploration to visualisation.

In $T_3 - T_6$, specifically Exercise 4.2, the tasks given are generally procedural and contextual. As seen in T_3, the questions still maintain a real-world context, complete with sub-questions that provide students with a framework and steps to solve the problem graphically. Moreover, in T_4, the questions are similar to T_3 but no longer accompanied by procedural steps. The tasks at $T_5 - T_6$ are more verification and calculation-based, where the choice of strategy is more limited. In general, the tasks show a shift towards a more closed approach but still maintain context.

From $T_1 - T_6$, it can be concluded that the book presents tasks that are diverse in terms of variety and are arranged with consideration of the level of complexity. $T_1 - T_2$ provides open-ended tasks that support students in constructing meaning, while its various derivatives demonstrate an effort to broaden the students' learning experience. However, the shift to the next task, $T_3 - T_6$, becomes too procedurally focused. There needs to be stronger continuity between exploratory tasks and exercises to ensure the learning process remains meaningful and reflective throughout.

In conclusion, $T1 - T6$ seems to cover several types of tasks, but it is necessary to pay attention to the imbalance between tasks to gain conceptual understanding and tasks to apply the concepts that have been obtained, which still seem to be lacking in mathematics textbooks [23]. An unbalanced distribution of task types can impact students' learning and understanding of mathematics [26]. The questions provided do not pay enough attention to the acquisition of inter-concepts, so that the proportion of questions for application is much greater. $T2$ upon further examination, these questions cannot be solved by students if they only rely on the knowledge obtained from $T1$. This reaffirms Putra's (2020) research,

namely that the majority of textbooks in Indonesia focus on formal mathematical tasks and standard techniques or algorithms rather than inter-contextual relationships [27].

***Technique* (τ)**

Based on an analysis of student textbooks, the techniques used to complete the tasks in the subchapters are shown in the following table.

Table 3. Technique

Technique (τ)	Description
T_1	Try to improve by using tables that encourage students to develop their own strategies. In the **Let's Think Critically** section, students are directed to perform point testing using the substitution technique.
T_2	Fill in the guess table, then transition to a mathematical model using linear inequalities. Then, in the **Let's Use Technology** section, students are asked to compare the results of manual work with the GeoGebra application.
T_3	Students are guided through sub-questions to use graphical techniques, starting from arranging two linear inequalities, drawing lines, point testing, and determining intersections.
T_4	Using graphical techniques, students can determine the system of inequalities and check the solutions. However, substitution techniques can also be used.
T_5	The technique is not specified, allowing flexibility, though it remains limited; students can use either graphical or numerical testing methods.
T_6	Students can use either graphical or substitution techniques; they choose combinations of values that satisfy the system.

At T_1, through open-ended questions, students are not directly directed to use formal techniques. Students are directed to try various informal strategies first, such as guessing values and using guess tables. This approach provides students with space to develop their own solution techniques intuitively, using their initial understanding. This technique aligns with the principles of constructivism and provides an authentic experience of constructing meaning before moving on to formal forms. In the "Let's Think Critically" section, the point test technique is introduced by substituting values to determine the region of the inequalities. The technique is presented directly, without explaining its relevance or how to develop it further.

Then, in T_2, similar to T_1, students are also instructed to solve problems using informal techniques by guessing the number of competitions and participants that might fit within the budget. Using contextual logic, students can employ various methods, such as table strategies, trial and error, or systematic approaches, to determine the combination of values that meet the requirements. The "Let's Discuss" section expands opportunities for students to compare the various techniques they use. However, the discussion is not accompanied by explicit guidance for exploring or developing alternative techniques. Additionally, the "Let's Use Technology" section introduces visualisation techniques using GeoGebra, but it only provides commands without the opportunity to develop them further.

Referring to the teacher's guidebook, it is clear that teachers are expected to encourage and guide students to try trial-and-error strategies at T_1 & T_2, but no explicit

reference to alternative techniques is provided to aid further discussion and exploration. Teachers were then encouraged to directly link this to prior knowledge from the previous subchapter, namely systems of linear equations in two variables or the inequality topic studied in junior high school. Alternative solutions using formal methods are then presented only in an instructional manner, with the steps written directly in the student's book, so that it is only a transfer of knowledge rather than the construction of knowledge itself. This condition reflects Chevallard's discussion (2006), which describes the separation between *praxis* and *logos* [28]. In line with this, research by Utami et al. (2024) reveals that almost all techniques for each task type are provided in textbooks, which then guide students towards imitation [18]. Thus, teachers' books merely reinforce instruction in the learning process rather than expanding students' opportunities to develop their own techniques.

$T_3 - T_6$ introduce more formal techniques. The tasks presented are more closed-ended, requiring a single answer or a few possible answers, and generally guide students to use graphical techniques to solve the problems. This book does not offer other techniques that can be used, such as numerical substitution or algebraic system approaches, so the variety of techniques introduced is very limited. The problems in this section lead to almost identical steps: constructing a model, drawing a graph, testing points, and then taking intersections. Similarities can be found in the teacher's guide, where all the answer keys contain graphical methods. Although graphical techniques are valid and important, students are overly directed to use them exclusively. Students are not given the space to choose, compare techniques, or modify steps according to context. This limitation is related to the limited scope of praxeology, in which textbooks restrict students to a single point of view rather than allowing for the emergence of different techniques [29].

The subchapter on Systems of Linear Inequalities in this book lacks consistency in providing students with space to develop and evaluate various solution techniques. Systems of linear inequalities, like other algebra topics, are not just about finding solutions, but also involve understanding the relationships and connections between various symbols and their application in solving various problems [30]. Techniques that should involve action and be obtained from student participation lose their meaning [31]. Tasks that are given gradually narrow the techniques students can use. This results in students applying only one dominant solution method, making the technique more procedural and making new knowledge more prone to being forgotten [32].

Logos Block

The analysis of the technological and technical components incorporated in the logos block serves as the basis for discourse in the praxis block [28] [29]. The logos section then explains, justifies, and reflects on the actions and techniques analysed in the praxis block. Through the analysis of these two components, it can be understood how and why certain techniques can be used to complete the given task. In the analysed textbook, only two solution techniques are accommodated, resulting in two local praxeologies.

The technological component in praxeology acts as a bridge between technique and theory [31], but it is not presented explicitly. For example, the section T_1 presents tasks

that encourage students to solve problems intuitively without formal techniques. There is a great opportunity for students to reflect on or justify the strategies used, such as why a particular guess might be the right solution. However, the book does not explicitly direct students to explain the reasons for their choice of technique. The section Let's Think Critically is slightly closer to the technological aspect, where students are asked to check whether a point belongs in the solution area. This is a simple justification of the results, the only part of the book that requires students to assess suitability directly.

From $T_3 - T_6$, almost all of the tasks are procedural in nature, so it is assumed that the technique used by students is standard, namely the graphical technique. The tasks are merely exercises and do not support the process of constructing or concluding the definitions and properties of the mathematics used. Implicit theory functions as a tool, something students are assumed to know and not part of their own construction. This results in a lack of bridge between mathematical experiences related to context and more conceptual formal principles and properties. Ultimately, solution techniques or strategies are only used as calculation tools, not as part of a thinking process that can be examined or questioned. The justification of techniques is not considered an important element in meaningful learning to encourage the development of students' conceptual understanding. Textbooks that focus too much on procedural skills can hinder the development of broader understanding, especially in the concept of algebra [21].

3.2. Discussion

The findings indicate that the presentation of systems of linear inequalities in two variables in the analysed textbook tends to emphasise the praxis block, particularly tasks and techniques, rather than the logos block, which consists of technology and theory. Although the textbook provides contextual and exploratory tasks, the explanations and justifications underlying the use of particular techniques are not sufficiently developed. As a result, students are guided to perform mathematical procedures, but they are not consistently encouraged to explain why these procedures are valid or how they are connected to formal mathematical concepts.

In the student textbook, opportunities to develop technological components are limited. For example, students are asked to solve problems using guessing, trial and error, substitution, and graphical methods. However, the textbook rarely asks students to justify why these methods can be used or to compare the efficiency and validity of different strategies. The use of GeoGebra is also presented mainly as a tool for visual comparison with manual graphs, rather than as a medium for evaluating, validating, or reflecting on mathematical results. This indicates that technology, in the praxeological sense, has not been fully integrated into students' learning activities.

The teacher's guidebook provides more explicit information about the conceptual structure of systems of linear inequalities in two variables. Teachers are encouraged to guide students in analysing mathematical models and identifying the characteristics that make the models systems of linear inequalities. However, this conceptual explanation is mostly presented as instructional guidance for teachers rather than as part of the learning process that students construct. Therefore, the relationship between the student textbook

and the teacher guidebook suggests that the development of theoretical understanding depends heavily on teacher intervention. If teachers do not explicitly elaborate on these concepts during instruction, students may engage only with the procedural aspects of the material.

From the perspective of praxeology, this condition reflects an imbalance between praxis and logos. The textbook provides tasks and techniques, but the discourse that explains, justifies, and connects these techniques to mathematical theory remains limited. In praxeological terms, techniques should not stand alone; they need to be supported by technology and theory so that students can understand not only how to solve a problem, but also why a particular technique works. Without this support, students may regard repeated procedures as self-evidently correct, even though they have not developed a deeper conceptual understanding.

These findings are consistent with previous studies showing that mathematics textbooks often emphasise procedural work more than conceptual explanation. González-Martín et al. [33] found that textbooks tend to focus more on praxis, which may reduce students' opportunities to understand the justification behind mathematical techniques. Similarly, Hendriyanto et al. [34] reported that Indonesian textbooks generally focus on problem-solving techniques without providing sufficient conceptual explanations. The present study extends these findings by showing that a similar tendency also appears in the topic of systems of linear inequalities in two variables in the Grade X Merdeka Curriculum textbook.

The limited attention to technology and theory has important implications for mathematics learning. When students are repeatedly exposed to procedures without being asked to justify their reasoning, learning may become mechanical and less reflective. Students may be able to draw graphs or test points, but they may not fully understand the meaning of the solution region, the role of inequality signs, or the relationship between contextual constraints and mathematical models. Therefore, teachers need to provide additional learning activities that encourage students to explain, validate, compare, and generalise their solution strategies.

Overall, the discussion shows that the analysed textbook has attempted to support contextual learning through real-life problems and exploratory tasks. However, these efforts have not been fully supported by explicit technological and theoretical components. The textbook, therefore, requires pedagogical intervention by teachers to bridge the gap between contextual tasks, procedural techniques, and formal mathematical understanding. Strengthening this connection is necessary to help students develop a more meaningful and reflective understanding of systems of linear inequalities in two variables.

4. CONCLUSION

Based on the praxeological analysis, the Grade X mathematics textbook under the Merdeka Curriculum, 2023 revised edition, presents the topic of systems of linear inequalities in two variables through various contextual and exploratory tasks. These tasks have the potential to help students construct mathematical models from real-life situations.

However, the transition from exploratory tasks to procedural exercises is not consistently developed, which may limit the continuity of students' conceptual understanding.

In terms of technique, the textbook mainly directs students to use graphical methods. Although this technique is relevant for solving systems of linear inequalities in two variables, the limited exploration of alternative strategies may restrict students' opportunities to compare, evaluate, and develop flexible problem-solving approaches. The technology component, which refers to explanations or justifications for the techniques used, receives limited attention. Similarly, the theory component is not explicitly presented in the student textbook, as formal definitions and mathematical principles are mostly assumed to be already understood by students.

The comparison between the student textbook and the teacher guidebook shows that the teacher guidebook provides some conceptual explanations. However, these explanations are mostly presented as instructional guidance for teachers rather than as activities that allow students to construct the concepts themselves. Therefore, the student textbook cannot fully stand alone in supporting meaningful learning. The effectiveness of the textbook depends greatly on teachers' pedagogical interventions in guiding, expanding, and deepening students' learning experiences.

These findings suggest that teachers should supplement textbook activities with tasks that encourage justification, reflection, and the comparison of strategies. Textbook authors are also encouraged to strengthen the connection between contextual tasks, solution techniques, conceptual explanations, and formal mathematical theory so that students can develop a deeper understanding of systems of linear inequalities in two variables.

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