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ANALYSIS OF SEVENTH-GRADE JUNIOR HIGH SCHOOL MATHEMATICS TEXTBOOKS ON ALGEBRA USING THE PRAXEOLOGY APPROACH

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ABSTRACT

Algebra material in mathematics learning plays a crucial role as the foundation for abstract thinking among junior high school students. However, obstacles in task design in textbooks often hinder students' understanding of basic algebra concepts. This study aims to analyze the algebra material in Grade VII mathematics textbooks using a praxeological approach. The research method employed is qualitative descriptive, consisting of observation through selection, categorization, coding, and in situ analysis. The analyzed textbook is the Grade VII Mathematics book published by the Ministry of Education and Culture in the 2017 revised edition. It was chosen due to its widespread use in schools across Indonesia. The main findings indicate that among the four task designs analyzed, many present epistemological and didactic obstacles, such as a lack of emphasis on fundamental algebra concepts and the presentation of unsystematic material. As a solution, this research proposes an alternative task design that focuses on contextual illustrations, independent exploration, and visualizations to enhance learning effectiveness. Although empirical validation has not yet been conducted, the findings provide a foundational framework for developing better algebra learning materials in the future. The implications of this research are expected to assist textbook developers and teachers in creating content that more effectively supports student learning.

Materi aljabar dalam pembelajaran matematika memiliki peran penting sebagai fondasi berpikir abstrak bagi siswa SMP. Namun, hambatan dalam task design buku teks sering kali menghambat pemahaman siswa terhadap konsep dasar aljabar. Penelitian ini bertujuan untuk menganalisis buku teks matematika kelas VII pada materi aljabar menggunakan pendekatan prakseologi. Metode penelitian yang digunakan adalah kualitatif deskriptif dengan tahapan observasi melalui seleksi, pengkategorian, pengkodean, serta analisis in situ. Buku yang dianalisis adalah buku Matematika Kelas VII terbitan Kementerian Pendidikan dan Kebudayaan edisi revisi 2017, yang dipilih karena penggunaannya secara luas di sekolah-sekolah Indonesia. Temuan utama menunjukkan bahwa dari 4 task design yang dianalisis, banyak yang menunjukkan hambatan epistemologis dan didaktis, seperti kurangnya penekanan pada konsep dasar aljabar dan penyajian materi yang tidak sistematis. Sebagai solusi, penelitian ini menyusun alternatif task design yang berfokus pada ilustrasi kontekstual, eksplorasi mandiri, dan penggunaan visualisasi untuk meningkatkan efektivitas pembelajaran. Meskipun validasi empiris belum dilakukan, temuan ini memberikan kerangka dasar untuk pengembangan pembelajaran aljabar yang lebih baik di masa

mendatang. Implikasi dari penelitian ini diharapkan dapat membantu pengembang buku teks dan guru dalam menyusun materi yang lebih mendukung pembelajaran siswa.

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1. INTRODUCTION

Algebra is one of the subjects taught to seventh-grade junior high school students and serves as a fundamental basis in mathematics learning. This material is crucial in training students to think abstractly and is a prerequisite for understanding subsequent mathematical concepts (Putra et al., 2020). At this stage, students transition from arithmetic-based learning to more abstract concepts. The difficulties experienced by students in understanding algebra at this stage align with Radford's (2012) view, which states that students' first encounter with abstract concepts often poses significant challenges.

These problems can be addressed through the use of textbooks during school learning. Textbooks in school learning are one of the tools that support an effective and systematic teaching and learning process. In the 2013 curriculum, the government provided textbooks for students and teachers. Student textbooks are the primary learning resource that guides students in achieving the expected competencies. However, in the teaching and learning process, teachers' reliance on textbooks is an initial means of delivering material along with examples and practice questions (Tanujaya, 2017). With the diverse range of book authors, problems encountered include errors in the written books, such as writing and practice question errors, or errors in the delivery of learning material concepts. One of the seventh-grade junior high school mathematics books used in this analysis is published by the Ministry of Education and Culture.

Essentially, textbooks are used to explain concepts within a subject. These concepts serve as markers of knowledge and are an important part of mathematical objects. Mastery of mathematical concepts is fundamental to mathematics learning (Kusmaryono et al., 2020). The importance of algebra lies not only in its conceptual aspects but also in its relevance to various fields of science and everyday life. As part of the curriculum, this material provides a foundation for students to master advanced topics such as equations, functions, and analysis. A deep understanding of algebra enables students to develop logical and analytical thinking skills that are highly needed in various academic and practical contexts.

The praxeology approach developed within the Anthropological Theory of Didactics (Chevallard, 1992; Chevallard, 2006) provides a framework for analyzing students' learning activities. Praxeology allows for the analysis of the structure of mathematical tasks, encompassing both praxis (practice) and logos (theory) components in learning activities (Bosch et al., 2020; Rasmussen, 2016). In this context, the praxeology approach becomes relevant for identifying epistemological and didactic obstacles faced by students in mathematics textbooks. Previous research indicates that epistemological obstacles can arise when students experience difficulties in

understanding the relationship between symbols and more abstract mathematical meanings (Putra & Witri, 2017; Wijayanti & Winsløw, 2017).

Furthermore, analysis conducted through the praxeology approach can assist teachers and researchers in identifying how learning tasks in textbooks can potentially create learning obstacles, both in task design and material presentation (Wijayanti & Winsløw, 2017). Thus, this approach is relevant to Indonesia's learning context as it helps design more effective tasks that align with the demands of the 2013 Curriculum, which emphasizes conceptual understanding and contextual learning. Therefore, this research aims to analyze seventh-grade mathematics textbooks on algebra using the praxeology approach and to develop alternative task designs to overcome students' learning obstacles.

2. METHOD

This study employs a descriptive qualitative approach to analyze the task design in seventh-grade mathematics textbooks. This approach was chosen to gain an in-depth understanding of the epistemological and didactic obstacles found in the algebra material (Sugiyono, 2014). The research subject is the *Matematika Kelas VII* (Seventh-Grade Mathematics) textbook, revised edition 2017, published by the Ministry of Education and Culture. This book was selected due to its high usage rate in Indonesian schools and alignment with the 2013 Curriculum.

Data collection was conducted through document observation. The observation involved selecting task designs related to algebra material, categorizing these task designs based on the types of epistemological and didactic obstacles, and assigning codes to each task design to identify the discovered obstacles. The analysis was performed directly on the task designs within the textbook to understand these obstacles.

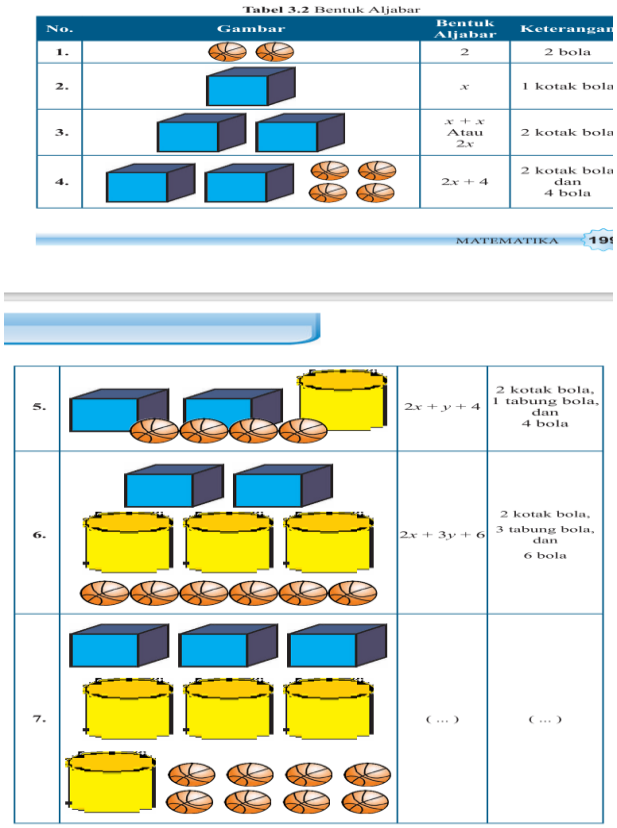
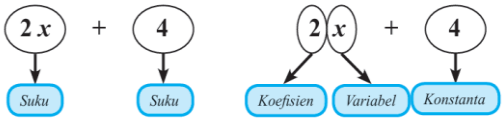
The collected data were analyzed descriptively and qualitatively to identify epistemological and didactic obstacles and to propose alternative task designs. The praxeology approach (Chevallard, 1992; Bosch & Gascón, 2006) was used as the analytical framework to understand the praxis (practice) and logos (theory) components within each task design, allowing for a systematic breakdown of the obstacles and proposed solutions.

3. RESULT AND DISCUSSION

The findings of this research consist of task design data analyzed based on the concept of praxeology, encompassing techniques, theories, and technologies within the seventh-grade algebra textbook. This data was gathered by observing the *Matematika* (Mathematics) textbook for the first semester of seventh grade, published by the Ministry of Education and Culture, 2017 revised edition. From all the tasks presented in the textbook, four task designs were identified as problematic based on the praxeology analysis. The following are the results of the analysis for these four selected task designs:

Table 1. Task Design Based on Praxeology

First Task Design	
Suppose: **x** represents the number of balls in one box **y** represents the number of balls in one tube	**Technique** Completing each algebraic form by following the procedure from top to bottom. **Technology**

"Each box contains the same number of balls." "Each tube contains the same number of balls."  Tabel 3.2 Bentuk Aljabar No. | Gambar | Bentuk Aljabar | Keterangan 1. | | 2 | 2 bola 2. | | x | 1 kotak bola 3. | | $x + x$ Atau $2x$ | 2 kotak bola 4. | | $2x + 4$ | 2 kotak bola dan 4 bola MATEMATIKA 19 5. | | $2x + y + 4$ | 2 kotak bola, 1 tabung bola, dan 4 bola 6. | | $2x + 3y + 6$ | 2 kotak bola, 3 tabung bola, dan 6 bola 7. | | (...) | (...)	The provided captions/instructions will assist in filling the algebraic form column. **Theory** Determining algebraic forms.
Second Task Design	
 From the illustration above, express in your own words (do not be afraid to be wrong): What is meant by: a. Coefficient? b. Variable? c. Constant?	**Technique** Stating the definitions of algebraic components. **Technology** Through the detailed diagram, one can identify terms, coefficients, variables, and constants. **Theory** Determining the definitions of coefficient, variable, and constant.
Third Task Design	
a. The total rice ordered for Mr. Madhuri is 15x + 20x or 35x kilograms. b. If Mr. Madhuri only fulfills the order for the Pasean market merchant, the remaining rice will be two sacks or 2 kilograms. c. Mr. Madhuri's rice shortage to fulfill the order for the Waru market merchant is three sacks or (−3x) kilograms of rice. (The negative sign indicates a shortage.) In the introductory story above, there are operations between two algebraic forms, namely: 1. Addition: (15x) + (20x) = 35x 2. Subtraction: (17x) − (15x) = 2x	**Technique** Completing the table concerning the addition and subtraction of algebraic forms. **Technology** Determining addition and subtraction by following the applicable rules. **Theory** Addition and subtraction of algebraic forms.

3. Subtraction: (17x) − (20x) = −3x

The form 17x − 15x can also be written as adding two algebraic forms (17x) + (−15x).

To learn more about the addition and subtraction of algebraic forms, let us observe and complete some additions and subtractions of algebraic forms in Table 3.3 below.

No.	A	B	$A+B$	$B+A$	$A-B$	$B-A$
1	$2x$	$3x$	$5x$	$5x$	$-x$	x
2	$x+2$	$x+7$	$2x+9$	$2x+9$	-5	5
3	$x+1$	$3x+8$	$4x+9$	$4x+9$	$-2x-9$	$2x+7$
4	$3x-2$	$2x-4$	...	...	$x+2$	$-x-2$
6	$2x-1$	$1-x$	x	x	...	...
7	$3x$	$2x+1$	...	...	$x-1$	$-x+1$
8	5	$2x-4$	...	$2x+1$	$-2x+9$	...

Fourth Task Design

Complete the empty cells in the table!

No.	A	B	$A \times B$	Keterangan
1.	5	$x+10$	$5x+50$	$(5 \times x)+(5 \times 10)=5x+50$
2.	7	$x-3$	$7x-21$	$(7 \times x)+(7 \times (-3)=7x-21$
3.	$x+10$	$x+3$	$x^2+13x+30$	$(x \times x)+(x \times 3)+(10 \times x)+(10 \times 3)$ $=x^2+3x+10x+30$ $=x^2+13x+30$
4.	$x-2$	$x+7$	$x^2+5x-14$	$(x \times x)+(x \times 7)+(-2) \times x+(-2) \times 7$ $=x^2+7x-2x-14$ $=x^2+5x-14$
5.	$x+1$	$3x-8$	$3x^2-5x-8$	$x \times (3x)+x \times (-8)+1 \times (3x)+1 \times (-8)$ $=3x^2-8x+3x-8$ $=6x^2-5x-8$
6.	$3x-2$	$2x-4$	$6x^2-16x+8$	$(3x)(2x)+(3x)(-4)+(-2)(2x)+(-2)(-4)$ $=6x^2-12x-4x+8$ $=6x^2-16x+8$
7.	$2x-1$	$1-x$	$-2x^2+3x-1$	$(2x) \times 1+(2x)(-x)+(-1) \times 1+(-1)(-x)$ $=2x-2x^2-1+x$ $=-2x^2+3x-1$
8.	x^2+4x	$3x-7$	$3x^2+5x-28x$	$(x^2)(3x)+(x^2)(-7)+(4x)(3x)+(4x)(-7)$ $=3x^3-7x^2+12x^2-28x$ $=3x^3+5x^2-28x$
9.	$x+a$	$x+b$	...	...

Technique

Deducing the multiplication of two algebraic forms based on the pattern from the examples.

Technology

The method for multiplying algebraic forms is derived from the pattern in the examples.

Theory

Multiplication of algebraic forms.

Table 1 displays the textbook's task design analysis based on the praxeology approach. The intended goal is for students to be able to determine algebraic forms. However, the task design in the first and second activities is less relevant to this goal. In the first stage, students are only asked to identify algebraic forms that match the pictures without in-depth exploration of the concept. Subsequently, in the second stage, the questions immediately focus on identifying terms, coefficients, variables, and constants, thus revealing a didactical obstacle. In the third and fourth task designs, students are guided to follow the examples presented. As a result, students are not allowed to deeply understand the concepts or develop new knowledge, which indicates an epistemological obstacle (Brousseau, 2002).

Regarding the techniques employed, no attempt was found to accommodate the diversity of students' knowledge, thought processes, or academic potential. This points to an ontogenic obstacle (Suryadi, 2019a), where the learning process fails to support individual development optimally. Based on this analysis, the researchers have formulated an alternative to address the issues present in the textbook. This alternative enhances the task design, aligning it with the praxeology approach. The proposed alternative task design is presented in Table 2 below:

Table 2. Alternative Task Design Based on Praxeology

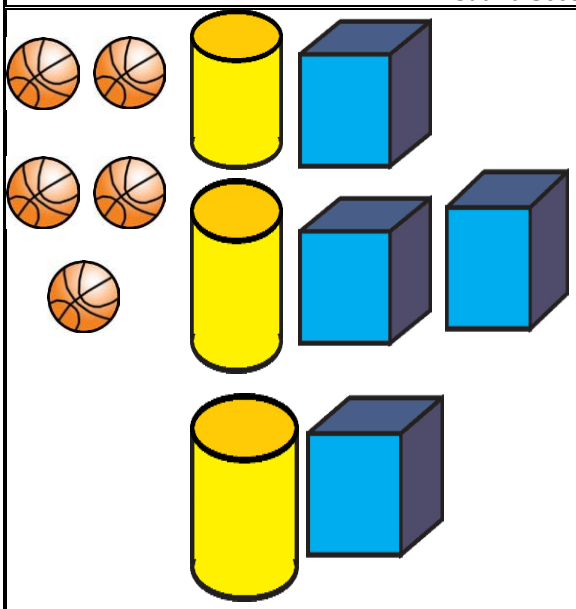
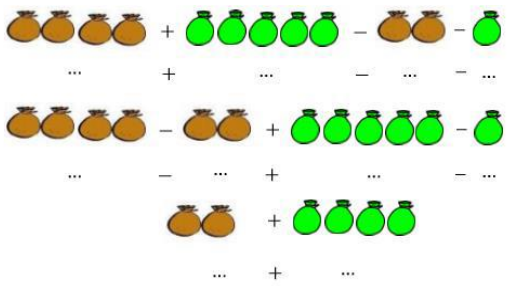
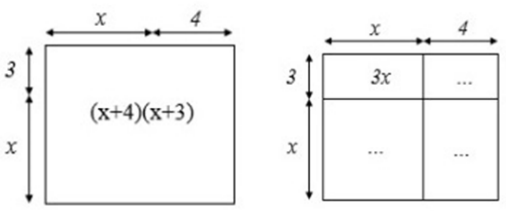
First and Second Task Design	
 If the tubes and cubes contain an unknown number of balls, and the number of balls in the cubes and tubes is different, express the illustrations above in algebraic form!	**Technique** The expected technique is for students to be able to determine variables, coefficients, and constants. **Technology** Students possess diverse learning experiences and abilities, thus allowing for a variety of answers. **Theory** Determining algebraic forms.
Third Task Design	
Joni, a small rabbit, has four bags containing an equal number of carrots, *m*, and five bags containing an equal number of seeds, *n*. If two bags of carrots and one bag of seeds are given to Jarjit, the lazy mouse-deer, how many carrots and seeds does Joni have left per bag? 	**Technique** The expected technique is for students to be able to calculate the results of addition and subtraction operations in algebraic form. **Technology** The learning experiences gained by students from the first and second task designs are expected to guide their thinking towards the desired technique. **Theory** Determining the addition and subtraction of algebraic forms.
Fourth Task Design	
Determine the result of the following multiplication! (x+4)(x+3) 	**Technique** Calculating the area of a rectangle by dividing it into several other shapes. **Technology** With the aid of a diagram, students are expected to be able to perform multiplication operations in algebraic form. **Theory** Determining the multiplication of algebraic forms.

Table 2 explains the alternative task design that can be used in learning, covering algebraic forms, addition and subtraction, and multiplication of algebraic forms. These four alternative task designs result from research conducted by the researchers. With the presentation of these alternative tasks for the algebra material in the *Matematika Kelas VII Semester 1* (Seventh-Grade Mathematics Semester 1) textbook, 2017 revised edition, published by the Ministry of Education and Culture, it is hoped that it can assist teachers in providing effective learning in the classroom and make it easier for students to understand algebra.

In the first task design, a problem was identified where students were directed to follow examples from a table, causing their focus on determining algebraic forms solely centered on the variables x and y. This led to confusion when variables were replaced with other symbols or letters. This problem arose because the questions in the first task design were not contextual. Context-based questions are essential for improving quality (Wahyudi et al., 2016). Students need questions that challenge them to think logically, question possibilities, seek alternatives, and use their imagination.

In the second task design, a similar problem occurred, where students were directly asked to state the definitions of coefficients, variables, and constants. However, students still recognized algebraic forms through tables at this initial stage. This problem caused a didactical obstacle in learning. The second task design focused more on students knowing the definitions of coefficients, variables, and constants rather than understanding the basic concepts of algebra. This happens because mathematics is often seen as a subject to be learned. In contrast, it should be viewed as a conceptual tool to construct mental objects such as definitions, theorems, proofs, problems, and solutions (Harel, 2008).

Based on the identified problems, the first alternative task design can be used to overcome the didactical learning obstacles in the first and second task designs. In this design, students are presented with real-world illustrations and asked to convert these illustrations into algebraic forms. Students have diverse learning experiences and abilities, allowing them to provide various answers. Mathematics learning is an effort to facilitate every learning process to run well (Suryadi, 2018). With this alternative design, students can explore different answers, which will deepen their understanding of algebraic forms and make that understanding stronger and more lasting.

In the third task design, a problem was found where students were directed to follow examples from a table. This meant students did not have the opportunity to make meaning and develop new knowledge. Consequently, an epistemological learning obstacle occurred for students. An inappropriate flow of material and a lack of emphasis on basic concepts reinforce the presence of didactical obstacles (Suryadi, 2013). Based on this problem, the third alternative task design can be used to overcome the epistemological learning obstacle. Students' learning experiences from the first and second alternative task designs are expected to guide their thinking towards the desired technique, enabling them to perform addition and subtraction operations in algebraic forms.

The fourth task design identified a problem where students were directed to follow examples from a table. This prevented students from making meaning and developing new knowledge, creating an epistemological learning obstacle. The lack of teaching aids can make it difficult for students to understand basic mathematical concepts (Nurjanah & Juliana, 2020). Based on this problem, the fourth alternative task design can be used to overcome the epistemological learning obstacle. With the help of

pictures, students are expected to perform multiplication operations in algebraic forms by calculating the area of a rectangle by dividing it into several other shapes.

This alternative approach is supported by international literature. Rasmussen (2016) emphasizes the importance of tasks integrating contextual and visual elements to help students understand the relationship between symbols and mathematical concepts. Furthermore, Chevallard (2006) indicates that the praxeology approach can be used to identify and rectify weaknesses in task design, particularly those related to epistemological obstacles.

The proposed alternatives are theoretically relevant and have the potential for practical application in learning. It is hoped that textbook developers will consider these elements to improve the quality of the presented material.

4. CONCLUSION

This study identified didactical and epistemological obstacles within the task design of the seventh-grade mathematics textbook. These obstacles encompass a lack of emphasis on fundamental algebraic concepts, an unsystematic presentation of material, and minimal use of visual aids. These findings indicate that while the textbook serves as the primary reference for learning, there is room for improvement in task design and material presentation to foster a deeper understanding among students.

As a solution, alternative task designs, formulated based on praxeology theory, are proposed to address these identified obstacles. These alternatives concentrate on developing tasks that are more contextual, exploratory, and supplemented with visualizations to support the comprehension of algebraic concepts. Hopefully, these recommendations will serve as a guide for textbook developers and educators in enhancing the quality of mathematics instruction.

Although empirical validation of these alternatives was not conducted in this study, further development involving trials and quantitative data is strongly recommended. This step is essential to ascertain the effectiveness of the proposed alternatives and to bolster this research's contribution to the broader improvement of mathematics learning. Consequently, this study offers a significant initial contribution by identifying learning obstacles and formulating theory-based improvement strategies for future implementation.

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