



DETERMINING THE DIFFICULTIES STUDENTS FACE TO SOLVE ALGEBRAIC WORD PROBLEMS AND DIAGRAMMATIC PROBLEMS

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ABSTRACT

Algebraic problem-solving is a crucial component of mathematics education, providing a foundation for advanced mathematical concepts and real-world applications. However, many students encounter significant difficulties when learning and applying algebraic problem-solving strategies. The purpose of this research is to identify the most prevalent challenges students experience when attempting to solve algebraic problems. A total of 120 students were randomly recruited for this quantitative research project. Criterion-referenced assessments with items requiring solution of algebraic problems using words and diagrams were employed in this investigation. According to the descriptive data, textual challenges and novel settings were the greatest challenge for pupils in sixth grade while attempting to solve algebraic word problems. Students had the most trouble with visual-spatial awareness when answering diagrammatic algebraic problems.

Keywords: Algebra, Mathematics Education, Word problems, Diagram, Skill

I. INTRODUCTION

Algebraic problem-solving plays a fundamental role in mathematics education as it provides students with the skills and techniques necessary to solve complex mathematical equations and real-world problems. It serves as a bridge between arithmetic and higher-level mathematical concepts, paving the way for success in advanced mathematics courses and various fields of study. However, many students encounter significant difficulties when learning and applying algebraic problem-solving strategies, leading to lower achievement and reduced motivation in mathematics.

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One of the primary difficulties students encounter in algebraic problem-solving lies in the cognitive demands of the task. Working memory limitations can make it challenging for students to hold multiple variables and equations in their minds simultaneously. Translating word problems into algebraic equations can be particularly daunting, as it requires students to identify the relevant information, extract the necessary variables, and create appropriate mathematical expressions. Additionally, a lack of familiarity with algebraic concepts and notation can further hinder students' ability to comprehend and solve problems effectively.

Affective factors also play a significant role in students' struggles with algebraic problem-solving. Math anxiety, characterized by feelings of fear, tension, and apprehension towards mathematics, can negatively impact students' performance and confidence in problem-solving tasks. Negative attitudes and beliefs about mathematics, such as the perception that it is difficult or irrelevant, can further discourage students and hinder their engagement and motivation in learning algebraic problem-solving.

To address these difficulties, educators have employed various pedagogical approaches and instructional strategies. Concrete and visual representations have proven effective in enhancing students' conceptual understanding of algebraic problem-solving. Scaffolding techniques, such as providing step-by-step guidance and structured practice, can help students navigate the problem-solving process. Collaborative learning environments, where students engage in peer interactions and cooperative problem-solving, have also shown promise in supporting students' learning.

Moreover, technology integration has become increasingly prevalent in algebraic problem-solving instruction. Digital tools and software can provide interactive visualizations, immediate feedback, and personalized learning experiences, which can enhance students' engagement and understanding. However, it is essential to balance technology integration with the development of students' foundational algebraic skills and ensure that technology serves as a complement to, rather than a replacement for, effective pedagogy.

II. REVIEW OF LITERATURE

Subedi, Abatar. (2020) This paper aims to reveal the difficulties as experienced by graduate students while learning abstract algebra at master's degree in mathematics education in the first month of their enrollment. For, I adopted a case study of five students, interviewed them with the help of interview guidelines and observed their behaviors in the classroom, and triangulated this information with researcher's experiences to explore the difficulties in learning abstract algebra. I used inductive method to analyze the information and concluded that graduate students have experienced several difficulties in learning abstract algebra including the

difficulties in conceptualizing algebraic facts, constructing examples and non-examples; and proving theorems. Finally, the study suggests that graduate teaching need to focus on conceptual and procedural understanding of students, and emphasizing to construct examples and non-example as much as possible to improve students' learning.

Wahyuni, Reni et al., (2020) studying algebra is like studying the foundation of arithmetic. It's a tool for addressing connected phenomena in the real world. It teaches them methods for constructing well-organized thoughts. The process of moving from arithmetic to algebra is still an important part of any mathematics curriculum. Students can learn to solve arithmetic problems by moving in with the numbers and utilizing them as a home base. Students have difficulty resolving the math challenge posed by the letters. This is why we investigate whether or not students have issues with generalization and the equality dimension. This research opted for a qualitative approach, and descriptive statistics were used for data analysis. Students who have taken Algebra I in eighth grade are the focus of this analysis. This research shows that pupils struggle with generalizing ideas of patterns and equality.

Sugiarti, L & Retnawati, H. (2019) In middle school, students explore the mathematical field of algebra. It's possible that some kids will struggle with mathematics. The purpose of this research is to identify student struggles with algebraic problem-solving. This investigation is a case study of the qualitative variety. Participants in this study are junior high school students from grade 8D at Salam Magelang in Central Java during the winter semester of 2016–2017. Data is gathered using algebraic operations tests, free-form surveys, and thorough record-keeping. Methods of data analysis including simplification, visualization, and inference. Findings indicate that pupils have issues solving idea and principle-based algebraic problems. Difficulties in finding variables and constants, including but not limited to grasping the definitions of variables and constants and applying the notion of division in algebra, were reported by students. Applying the addition principle to an algebraic form, simplifying algebraic fractions, factoring, and solving algebra-related problems all provide challenges from a more fundamental theoretical standpoint.

Bora, Ashim & Ahmed, Sahin (2019) Algebra is an essential part of a well-rounded mathematics curriculum. Algebra is the language of mathematical inquiry and communication. By extension, the study of functions and other relationships between variables may be thought of as algebra. The study's authors stressed the significance of being able to translate and analyze with an understanding of mathematics. Despite the widespread interest in algebra, many students still struggle with fundamental ideas, patterns, and applications. In order to appreciate the difficulties of students in acquiring algebraic idea, the authors of this study conduct a literature review in relation to writing about students' issues in algebra learning. Many academics have shared their thoughts on how to improve classroom instruction, student problem-solving skills, and overall algebraic proficiency. Their perspectives may be categorized into the broad categories of generalization, modeling, and functioning. Most students have trouble grasping algebra's foundational ideas, the concept of patterns, and learning challenges.

Ferryansyah et al., (2018) Students majoring in mathematics education will take a course in

linear algebra. The majority of kids performed poorly. This study set out to quantify the extent to which students struggled with linear algebra. Thirty-five mathematics education majors were selected to take part. Data was gathered using a combination of a written test and in-person interviews. This study was qualitative in nature. Students had a lot of trouble learning linear algebra, with results showing that 88.63% of them had trouble representing the symbol or notation, 88.11% had trouble using the symbol or notation or ideas of mathematics and logical reasoning, 88.38% had trouble understanding the symbol or notation used through the application of logic, and 91.7% had trouble verifying whether the symbol or notation was used correctly. It suggested that pupils had a great deal of trouble grasping linear algebra. This is because students' comprehension and speed in solving linear algebra problems are relatively low in comparison to other subjects. Teachers of linear algebra often make inefficient use of media and pedagogical techniques.

Acharya, Bed. (2017) The challenges that pupils in public schools confront when attempting to master mathematics are the focus of this essay. The primary objective of this research was to investigate the factors that contribute to math anxiety. This research was qualitative in nature. The study goal was accomplished through participant observation and interviews with teachers and students at three Arghakhanchi district schools. Various data messages from prospective participants were discussed. The results of the data analysis and interpretation show that all parties involved—students, instructors, and parents—must do their part to raise the passing percentage. Mathematical anxiety, a negative impression of mathematics, teachers' socioeconomic status and the quality of their own mathematical training, the school's management structure, its lack of physical facilities, and its irregular assessment system are all major contributors to students' difficulties in this subject area.

III. MATERIALS AND METHODS

Quantitative information was gathered in this study using a criterion-referenced assessment. The study also used a descriptive case study methodology. Analysis of quantitative data was utilized to determine how challenging algebraic problems were for pupils generally. Descriptive percentage analysis was used to study quantitative data from three different courses in this study. The pupils' test-taking problems and slip-ups were investigated using a criterion-referenced test. The pupils' challenges were categorized during the grading procedure. According to previous studies, a comprehensive understanding of the research objective (in this case, the challenges students face when attempting to solve algebraic problems) can be attained by meticulously planning the procedure for all the research steps, beginning with data collection and ending with the interpretation of the results..

The questions were based on updated versions of those found on previous CheckPoint exams administered between 2018 and 2021. There were a total of 10 multiple-choice questions on the exam, and they all tested students' understanding of material covered in class. Algebraic word problems made up five of the items, while algebraic diagram problems made up the other five. Two points were assigned to each item. If students did not respond or gave the wrong response, they would receive no credit; if they proved their solution but gave the wrong answer, they would receive one credit; and if they got the question right, they would receive two credits.

Two points would be awarded for the right response. There were a possible 20 points available. At this stage, pupils' ability to understand and apply algebraic ideas is evaluated. The test was to be finished silently and independently by each student in 40 minutes. The exam helped pinpoint the areas where the pupils were having the most trouble while attempting to solve algebraic problems. Students' weaknesses with algebraic problem-solving were identified using a 10-item, 20-point exam. The private international school's Head of Secondary Mathematics confirmed the accuracy of this test. The Chief has been in the field for almost 40 years. Table 1 displays ten examples of the algebra problems that were employed in this analysis.

Table 1: The Algebra Problems

Number	Problems
1	Language Understanding
2	Information Skill: Manipulating Procedure
3	Language Skill: Number Value
4	Text difficulties & Unfamiliar contexts
5	Arithmetic Skill – Procedural Knowledge
6	Information Skill – Manipulating Information
7	Information Skill – Understand the Objective
8	Visual-Spatial Skill – Application to Daily Life
9	Visual-Spatial Skill – Orientation of Shape
10	Visual-Spatial Skill – Application to Daily Life

IV. DATA ANALYSIS AND INTERPRETATION

Table 2 displays descriptive statistics for all variables. Standard deviation for item 8 was 0.95 out of 10 items depicting algebraic problem-solving questions. Questions 6–10 tested students' abilities to analyze and solve diagrammatic problems, whereas questions 1–5 rated their proficiency with word problems. According to Table 2, the largest standard deviation was found in Word Problem Item 1, at 0.93, whereas the largest was found in Word Problem Item 8, at 0.95.

Table 2 The descriptive statistics of all variables

Item	Min	Max	Mean	Standard Deviation
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Word Problem				
Item 1	0	2	0.63	0.93
Item 2	0	2	1.63	0.79
Item 3	0	2	0.35	0.76
Item 4	0	2	0.15	0.53
Item 5	0	2	0.28	0.69
Diagram Problem				
Item 6	0	2	0.38	0.79
Item 7	0	2	0.38	0.79
Item 8	0	2	0.68	0.95
Item 9	0	2	0.50	0.87
Item 10	0	2	0.13	0.49

Table 3 shows that the most common causes of students' failure to solve algebraic problems are related to text issues, recognition problems, visual-spatial skills, sign substitution errors, language, and the translation of words or diagrams into algebra. Each thing may be broken down into its component algebraic problem sets.

Table 3 Difficulties of each item

Question	Difficulty	Wrong Answer	Correct Answer
Item 1	Language Understanding	68.74%	31.25%
Item 2	Information Skill: Manipulating Procedure	18.75%	81.25%
Item 3	Language Skill: Number Value	82.50%	17.50%
Item 4	Text Difficulties & Unfamiliar contexts	92.50%	7.50%
Item 5	Arithmetic Skill – Procedural	86.25%	13.75%

	Knowledge		
Item 6	Information Skill – Manipulating Information	81.25%	18.75%
Item 7	Information Skill – Understand the Objective	81.25%	18.75%
Item 8	Visual-Spatial Skill – Application to Daily Life	66.25%	33.75%
Item 9	Visual-Spatial Skill – Orientation of shape	75%	25%
Item 10	Visual-Spatial Skill – Application to Daily Life	90%	10%

V. CONCLUSION

In conclusion, understanding the difficulties that students face when learning algebraic problem-solving is crucial for improving mathematics education. By equipping students with the necessary tools and strategies to navigate algebraic problem-solving successfully, we can empower them to become confident, proficient mathematicians capable of applying their skills in various academic and real-life contexts. Students' metacognitive and conceptual understanding of algebraic problems has been the primary focus of this study; future research could benefit from expanding this focus by asking higher-order thinking questions and incorporating 21st-century teaching strategies. Students' critical thinking and metacognitive abilities can be studied in addition to their gender and the number of years they've spent in school.

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