

**ANALYSIS OF STUDENTS' ERRORS IN SOLVING ALGEBRAIC PROBLEMS
BASED ON THE STAGES OF KRULIK AND RUDNICK IN
GRADE IX JUNIOR HIGH SCHOOL**

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ABSTRACT

Problem-solving ability is one of the essential competencies in mathematics learning, particularly in algebra. However, in the problem-solving process, students often make errors that indicate difficulties in understanding concepts and determining appropriate solution strategies. This study aims to analyze students' errors in solving algebra problems based on the problem-solving stages proposed by Krulik and Rudnick, which include reading and thinking, exploring and planning, selecting a strategy, finding an answer, and reflecting and extending. This research employed a descriptive qualitative approach involving 24 ninth-grade junior high school students. The data were collected through a problem-solving test consisting of five algebra questions and analyzed based on the stages of problem solving. The results indicate that students' problem-solving abilities vary at each stage. A total of 83% of students were able to understand the problem at the read and think stage, 75% were able to plan the solution at the explore and plan stage, and 71% were able to select an appropriate strategy at the select a strategy stage. At the find an answer stage, the success rate decreased to 67% due to procedural errors in algebraic calculations. The lowest level of success occurred at the reflect and extend stage, where only 50% of students rechecked their answers. The dominant errors found include procedural errors in calculations, conceptual errors in understanding algebraic concepts, and difficulties in translating word problems into mathematical models.

Keywords: *error analysis, problem solving, algebra, Krulik and Rudnick, junior high school students.*

A.INTRODUCTION

Mathematics is one of the topics that has a vital position in developing students' logical, analytical, systematic, and important questioning capabilities. Mathematics getting to know isn't always best oriented to getting to know standards and numeracy capabilities; however, it

additionally emphasizes students' potential to clear up various issues confronted. Therefore, hassle-fixing competencies are one of the most important abilities that scholars should have in studying arithmetic. Problem solving is the center of mathematics, getting to know that, through this system, students learn how to

understand troubles, plan solution techniques, put into effect plans, and re-compare the answers received (Polya, 1973). The importance of problem-solving skills is also emphasized through the National Council of Teachers of Mathematics, which states that problem-solving is one of the standard methods in arithmetic mastery. Through problem-solving sports, students can increase advanced thinking capabilities and enhance their understanding of mathematical concepts more deeply (NCTM, 2000). As a result, arithmetic studying ought to not only focus on the final outcomes of the form of correct solutions, but also on the thinking process that students use in solving a problem. However, various studies show that students' mathematical problem-solving skills are still relatively low. Many students have difficulty understanding problems, determining the right solution strategies, and doing calculations correctly when solving math problems (Rahman & Sari, 2021). These difficulties are often seen in the mistakes made by students in the process of solving mathematical problems.

One of the mathematics subjects available in junior high school is algebra. Algebraic cloth has a crucial function in mathematics mastery due to the fact that it is the basis for various mathematical principles at higher education levels. Learning algebra entails the use of symbols, variables, and mathematical operations that require a good understanding of concepts. In solving algebraic issues, college students are not required to manipulate symbols, but also must be able to understand problems, bring together mathematical models, and determine the proper answer method (Hidayat, 2020).

College students' errors in solving algebra issues may be a hallmark of difficulties in mathematical information standards or approaches. Therefore, evaluation of scholar mistakes is crucial to be performed in order that the types and reasons of mistakes made by college students can be acknowledged. By way of knowing the errors that scholars make, instructors can obtain information about students' studying problems so that they can lay out extra powerful learning techniques.

One of the approaches that may be used to investigate the scholar's hassle-solving process is the hassle-fixing stages proposed by Stephen Krulik and Jesse A. Rudnick. The trouble-fixing model includes five stages: specifically, examine and suppose, explore and plan, select an approach, find an answer, and mirror and enlarge. This degree describes the systematic questioning procedure of students in solving a mathematical problem (Kruklik & Rudnick, 1995).

A few previous studies have shown that students' errors in solving mathematical problems often arise at the stage of information issues, choosing solution techniques, and doing calculations. In addition, some college students also do not often double-test the answers obtained (Putri & Wijaya, 2022). This indicates that the scholar's trouble-fixing method has not been performed systematically in accordance with the trouble-solving level.

Based on this description, the objectives of this examine are: (1) reading college students' errors in solving algebraic troubles based on the levels of Kruklik and Rudnick problem solving in grade IX junior excessive college students, (2)

figuring out the types of errors made by way of college students at every level of hassle solving, (three) Describing the elements that purpose scholar errors in fixing algebraic issues. Based on the history that has been described, the components of the trouble in this take a look at is: (1) How are the mistakes of college students in fixing algebraic issues? Based on the tiers of trouble fixing proposed via Stephen Kruklik and Jesse A. Rudnick in grade IX junior high school college students, (2) What are the sorts of mistakes that scholars make at every stage of algebraic trouble-solving, (3) What are the factors that cause college students to make mistakes in fixing algebra?

B. RESEARCH METHODS

This study uses a qualitative approach with a descriptive kind of research. The qualitative descriptive technique is used to explain in-depth the hassle-solving skills of students and identify mistakes made by way of students in solving algebra issues based on the tiers of trouble solving in line with Stephen Kruklik and Jesse A. Rudnick. This study aims to acquire a clear picture of the students' problem-solving procedure in solving issues

and the mistakes that arise at each stage of problem-solving.

The subjects in this study were 24 junior high faculty grade IX students. The choice of topics is performed purposively, considering that scholars have studied algebraic material associated with the studies. This research was executed within the even semester of the contemporary academic year.

The research instrument used was a look at mathematical problem-solving capability in algebraic material, which consisted of five description questions. The questions are designed to measure students' abilities at every stage of trouble fixing, specifically studying and thinking, exploring and making plans, deciding on an approach, locating an answer, and reflecting and increasing. Similarly to the take a look at, the researcher also makes use of interview recommendations to obtain more in-depth information about college students' thinking approaches and mistakes made in solving issues.

The records collection technique in this study was completed through the supply of trouble-fixing tests to all research subjects. Furthermore, several college students

had been selected to be interviewed based on the outcomes of their work to obtain further explanation of the entire steps taken. The information acquired was in the shape of pupil work effects and interview effects.

The records evaluation technique is done via several stages, namely data reduction, data presentation, and an end drawn. Inside the statistics discount stage, the researcher recognized and grouped pupil errors based on the Krulik and Rudnick trouble-fixing degrees. Furthermore, data is presented in the form of descriptions and probabilities to explain college students' capabilities at every degree of problem-solving. The remaining stage is drawing conclusions based on the consequences of the facts evaluation that has been performed.

This research method is expected to offer a comprehensive review of college students' hassle-solving competencies and the kinds of mistakes encountered in fixing algebra issues, in keeping with the levels of Krulik and Rudnick's problem-fixing framework.

C. RESULTS AND DISCUSSION

This looks at describes the effects of the evaluation of college students' errors in solving algebraic problems based on the ranges of hassle solving proposed by means of Krulik and Rudnick, specifically read and think, discover and plan, select an approach, locate an answer, and mirror and make bigger. The analysis was accomplished on the outcomes of the hassle-solving take a look at given

to 24 junior excessive college grade IX students.

The effects of the take a look at show that scholars' problem-solving capabilities nevertheless range at each stage. Most college students are capable of understanding the problem given; however still have difficulty in determining the proper solution strategy and double-checking the solutions received. The proportion of student fulfillment at each level of problem solving is provided in Table 1.

Table 1. Student Success Percentage at Each Stage of Problem Solving

Troubleshooting Stages	Number of Students	Percentage
Read and Think	20	83%
Explore and Plan	18	75%
Select a Strategy	17	71%
Find an Answer	16	67%
Reflect and Extend	12	50%

Primarily based on Table 1, it can be seen that the read and think stage has the very best achievement rate of eighty-three %. This shows that most college students are able to understand the statistics contained in the questions and discover what is known and what is asked. In contrast, the replicate and make bigger stage has the lowest success rate of 50%. This shows that some college students aren't used to reflecting or rechecking the solutions received. Those findings display that the

student's problem-solving process has not fully followed the systematic hassle-fixing stages as stated by Krulik and Rudnick (Krulik & Rudnick, 1995). However, there are nevertheless 4 college students (17%) who have a problem understanding the story. Errors that occur include students not writing down information, which is regarded as completely, and misinterpreting the meaning of the question. Mistakes at this level show that students' mathematical literacy competencies still need to be

improved. The potential to study and understand troubles is very important because it is the premise for the process of fixing mathematical issues (OECD, 2019).

The explore and plan stage is the stage when college students start to devise problem-solving techniques. At this stage, college students are predicted so that it will decide on the concept or method in order to be used to remedy the trouble. The results showed that 18 college students (seventy five%) were able to devise their completion pretty well. Students can decide the solution steps as well as pick relevant algebraic principles to solve the problem. In contrast, there had been 6 students (25%) who had difficulty in determining the completion plan. The error that often occurs at this stage is the pupil's incapacity to relate the statistics contained in the question to the appropriate mathematical concept. This shows that students' understanding of algebraic principles continues to be not top-rated. Understanding standards is one of the critical elements in determining mathematical problem-fixing strategies (Hidayat, 2020).

The pick a strategy stage is the level when students pick out the right

strategy to remedy a pre-deliberate hassle. Based on the outcomes of the evaluation, 17 students (71%) have been able to pick out the right completion strategy. Most students use the linear equation technique to solve the given problem. But there have been 7 students (29%) who chose the wrong strategy. errors that occur at this degree encompass the usage of inappropriate settlement strategies and mistakes in determining variables. This mistake indicates that a few students nonetheless have issues connecting algebraic standards with the given hassle.

The discovery stage is the stage of implementation of the strategy that has been selected. At this degree, students perform a calculation technique to acquire solutions to problems. The consequences confirmed that the scholar fulfillment price at this level reduced to 67%. This decrease is caused by procedural mistakes in algebraic calculations. Some of the errors that can be frequently discovered include: (1) mistakes in algebraic operations, (2) errors in simplifying algebraic expressions, and (three) errors in the manipulation of equations. The mistake suggests that

the scholar is no longer able to put into force the selected problem-solving strategy.

The replicate and expand stage is the closing stage in the problem-fixing method. At this degree, students are predicted to be able to re-study the answers obtained and compare the finishing touch technique that has been carried out. The consequences showed that only 12 students (50%) double-checked the solutions. Most

students quit immediately upon getting the answers without verifying the consequences obtained. The low potential of students at this level indicates that the dependence of reflection in arithmetic learning continues to be not nicely evolved.

Based on the results of the analysis of student work, three main types of mistakes were found by students in solving algebraic problems.

Table 2. Types of Student Errors in Algebraic Problem Solving

Error Types	Number of Students	Percentage
Conceptual Errors	9	37%
Procedural Errors	11	46%
Modeling Errors	8	33%

Based on Table 2, it can be seen that procedural errors are the most dominant type of error, which is 46%. Procedural errors occur because students do not understand the steps to solve systematically and are not thorough in making calculations. Meanwhile, conceptual errors occur because students have not fully understood the basic concepts of algebra. Mathematical modeling errors occur when students have difficulty in converting story problems into mathematical equations.

DISCUSSION

The results of this study display that scholars' mathematical problem-solving skills in algebra subjects are still not developed optimally and tend to be choppy at every level of problem-solving. This locating reinforces the trouble that has been defined inside the introduction, that mathematics gaining knowledge of in colleges is still dominated by a procedural method, so that it has not fully prepared students to think systematically and reflectively.

While reviewed primarily based on the levels of problem fixing, students show noticeably suitable

overall performance in the early stages, namely, reading and writing. Most college students have been capable of becoming aware of the facts that are regarded, and this is what is asked in the question. This situation shows that scholars are quite used to dealing with troubles with a shape much like the example given by the teacher. But, there are still college students who are not careful in knowing the meaning of the questions, specifically in questions in the form of tales. This indicates that scholars' mathematical literacy abilities still need to be advanced. The potential to understand problems is a critical part of mathematical literacy, which is the premise for the trouble-solving manner (OECD, 2019). In other words, inaccuracies within the early stages will have a right away effect on the later degrees.

On the explore and plan level, students' talents begin to reveal more apparent variations. Some students are able to lay out a completion step by associating the available records with applicable algebraic principles, while others nevertheless have issues in figuring out a completion plan. This circumstance suggests that students' knowledge of ideas has no longer

been deepened. Students have a tendency to keep in mind formulas without understanding their use contextually. Hidayat (2020) states that "students' mistakes in trouble solving are regularly rooted in a vulnerable understanding of fundamental ideas". This assertion is consistent with the findings of this study, wherein students have trouble when they have to narrate concepts to situations that might be different from the same old examples given.

Students' problems are more and more visible at the pick-out a strategy level. At this degree, a few students pick strategies that are not suitable or not in accordance with the given trouble. This suggests that students are not used to considering diverse alternative strategies before determining the completion step. Students tend to use the most familiar strategies without doing the evaluation first. Krulik and Rudnick (1995) verify that "choosing the right strategy is the middle of successful hassle solving". Thus, mistakes at this degree imply that scholars do not have ok strategic thinking capabilities.

In terms of finding a solution, the most dominant blunders are procedural mistakes. Despite the fact

that students have decided on an appropriate strategy, there are nevertheless many who make errors in the calculation procedure. These errors include errors in algebraic operations, errors in simplifying bureaucracy, and a lack of precision in manipulating equations. Those findings recommend that students' simple math capabilities nonetheless need to be strengthened. Further, the accuracy factor is likewise a crucial aspect that affects the very last end result. In this case, procedural errors are not only related to technical capabilities, but also to the behavior of college students in working systematically.

The mirror and enlarge level is the degree with the lowest achievement. Most students do not double-take a look at the solutions received. After finding the very last end result, college students generally tend to jump right away without being certain of the reality. This suggests that reflection has not yet become part of college students' gaining knowledge of behavior. NCTM (2000) emphasizes that "mirrored image helps college students apprehend their personal idea method as well as improve the quality of learning". The

low capability at this degree indicates that the arithmetic mastery that has taken place up to now is more oriented in the direction of the final result than the technique.

Basically, the sample of scholar mistakes in this take a look at shows that problem-solving capabilities have not been completely evolved. Students generally tend a good way to do so in the early degrees, which are easy; however decline in the levels that demand evaluation, evaluation, and reflection. This finding is in line with Putri and Wijaya (2022), who said that students have problem-solving non-habitual issues because of a lack of experience in excessive-degree questioning.

In addition, the predominance of procedural errors indicates that arithmetic studies still focus on mechanistic sporting activities. college students are used to following the of entirety steps without understanding the reasons behind each step. As a result, when faced with special issues, college students have problems adjusting to the strategies that have been discovered. This circumstance suggests the significance of shifting the learning method from a procedural one to one that emphasizes

information principles and problem-solving.

Primarily based on the effects of this study, teachers want to design learning that is more system-oriented. College students want to be acquainted with the following levels of fixing problems systematically, starting from understanding the problem to reflecting on the answers acquired. Further, instructors additionally want to provide varied and contextual questions so that scholars are used to going through problems that require advanced-level questioning. Thus, mathematics mastery focuses not only on accomplishing the final end result but also on developing students' questioning abilities as a whole. This attempt is expected to enhance students' trouble-fixing abilities, especially in algebraic subjects, so that scholars are not only capable of clearing up routine issues, but also able to face various extra complicated issues.

D. CONCLUSION

Based totally on the effects of the studies that have been carried out, it can be concluded that the problem-solving ability of grade IX junior high

college students in algebra fabric, based on the degrees of Krulik and Rudnick, nevertheless varies at every degree of problem-solving. The degree with the very best success rate is read and suppose, whilst the stage with the bottom achievement rate is mirror and expand. The varieties of errors college students make in solving algebra problems encompass conceptual errors, procedural mistakes, and mathematical modeling mistakes.

RECOMMENDATIONS

Based totally on the results of this take a look at, some of the suggestions that can be given are: (1) instructors want to provide more various problem-solving sports in arithmetic gaining knowledge of, (2) arithmetic studying needs to emphasize greater on knowledge algebraic ideas, (3) teachers want to get used to students to double-take a look at the answers obtained as part of the mirrored image process in trouble solving.

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