MICESHI Proceeding
Available online at: https://ojs.unimal.ac.id/mijeshi/MICESHI
Vol. 1, No. 1, Januari 2024,

Analysis of Student Errors in Solving Type Mathematics Problems *Higher Order Thinking Skills (HOTS)*

*Corresponding author: pansbim@gmail.com
Bima Pambudi[1], Iryana Muhammad[2], Aklimawati[3], Muhammad Ichsan Abda[4], Anita Candra Dewi[5], Mona Refaat Taman[6]
[1 2 3]Universitas Malikussaleh, Aceh,Indonesia
[4]Universitas Negeri Yogyakarta
[5]Universitas Negeri Makassar
[6]Future Learders' International Group
iryana.muhammad@unimal.ac.id
aklimawati@unimal.ac.id
muhammad0400fmipa.2022@student.uny.ac.id
anitacandradewi@unm.ac.id
monataman32@gmail.com

ABSTRACT

Mathematics is a subject that inspires vision and sets a standard for scientists, particularly in the realm of logical intelligence. Mathematics research is increasingly focused on global challenges. for students are constructing breakthroughs in critical thinking and problem-solving. This research aims to describe the types of errors students make while solving Higher Order Thinking Skills (HOTS)type statistics math problems and identify factors causing errors in solving HOTS.The research method uses both experimental and qualitative methods, including case studies. Nineteen students from class VIII-A were involved in using tests, interviews, and documentation methods for data collection. The techniques employed in analyzing data include data reduction, presentation, and drawing conclusions. To ensure data accuracy, triangulation techniques are employed, specifically source triangulation. The results indicated that students made various errors in question 1, including reading, comprehension, transformation, skill, and final answer writing errors. Question number 2: errors can occur in reading, understanding, transforming, skill application, or last answer writing.3) Question number 3 includes reading, transformation, and process skills errors. These errors are caused by students needing to read statements and questions carefully. The crucial factor for students to solve problems is retrieving data from the details of the questions, for error analysis, Newman, HOTS, and statistics.

Keywords: error analysis, Newman, HOTS, statistics

1. INTRODUCTION

The mathematics learning system in Indonesia aims to help students develop logical thinking from an early age, making reading and calculation enjoyable instead of intimidating. However, the quality of mathematics education in this country is lower when compared to others. Therefore, students require sufficient human resources to enhance the quality of mathematics. The course has diverse problems, such as a need for student ability and effective learning techniques, and significant technology mastery issues in math lessons.

Newman's theory, as described in Kurnia & Yuspriyati (2020: 117-118), suggests that errors in math problem-solving stem from misconceptions, lack of knowledge, or carelessness. Reading, comprehension, transformation, and processing skill errors are all types of mistakes that can occur. The student showed a low interest in mandatory subjects at primary and secondary education levels, resulting in an encoding error (writing the final answer). Developing mathematical abilities can help students think logically. Researchers selected statistics as it is a scientific study of collecting, organizing, presenting, analyzing, and representing data. Such criteria require students to think at a higher cognitive level in line with Bloom's taxonomy.

Students' lack of motivation to study Mathematics is often due to unclear instructions and poor presentation of the subject matter. Yasmin (2016) suggests that learning difficulties hinder

success in mathematics by affecting students' abilities in logical, critical, consistent, disciplined, democratic, communicative, and honest thinking. Mathematics is a tool that fosters creativity, precision, critical thinking, innovation, logical reasoning, and hard work, but only with occasional errors in problem-solving.

The research will be discussed as follows based on the problem background: What errors do students make in solving Higher Order Thinking Skill (HOTS) type mathematics problems in statistics material? What factors lead students to make mistakes when solving statistics problems that require higher-order thinking skills (HOTS)? The researcher has two objectives based on these issues:

1. What are the common mistakes students make when solving Higher Order Thinking Skill (HOTS) mathematics problems in statistics? 2. Describe the factors that lead to errors when solving Higher Order Thinking Skill (HOTS) mathematical problems in statistics.

Newman (in Kurnia & Yuspriyati, 2020: 117-118) explained the error categories. 1. Reading errors: Students make errors when explaining questions, not reading or using the question, or misunderstanding the question. One of the indicators of a problem is the inability to understand or misinterpret the symbols in the question. Student can lead toa misunderstanding of the intended meaning. Additionally, if one cannot read the words in the question, it is considered a comprehension error. This error occurs when a student needs to understand the concept being tested, possess the necessary background knowledge, or comprehend the information presented in the question. As a result, the student needs help to solve the given question.

2. LITERATURE REVIEW AND HYPOTHESIS

This study focuses on analyzing the mistakes made by students when answering math questions. Mistakes are defined as inaccuracies or exclusions, according to the "Big Indonesian Dictionary" (Suharsono & Retnoningsih, 2012: 442), and can be either unintentional or systematic deviations from something correct, as explained by Amir (2015: 137). Math errors are typically caused by a lack of mastery of the material or confusion about problem-solving steps.

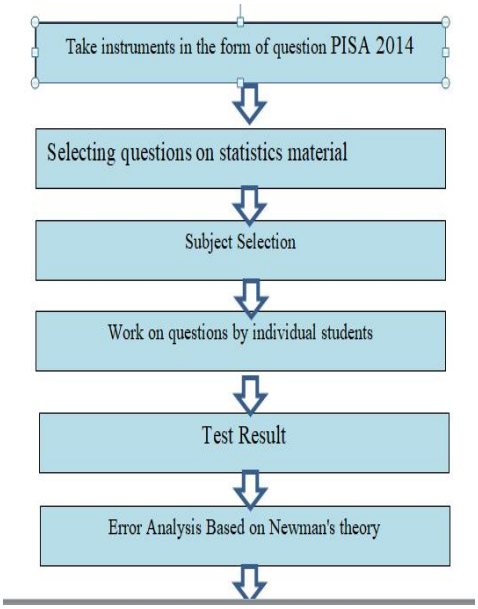
Error analysis is necessary to identify and explain student errors, which involves investigating the underlying circumstances, including causes, reasons, and facts. This process helps in determining the root causes of students' mistakes when solving problems.

According to Wiyartimi (in RiniYulia, Fauzi, Awaluddin. 2017:124-131), students can make various types of errors when solving math problems. These include conceptual errors, principle errors, operation errors, and errors due to carelessness. Kurnia & Yuspriyati's (2020) work, Newman provides a breakdown of error categories, which includes reading errors, comprehension errors, transformation errors, and process skill errors.

Reading errors occur when students have difficulty reading and understanding the questions, while comprehension errors happen when students do not understand the concept or cannot capture the information in the questions. Transformation errors occur when students have trouble converting problems into mathematical models or utilizing arithmetic operations. Process skill errors are caused by a lack of proficiency in calculation methods. The indicators of errors can be categorized into three types: computing errors, settlement procedure errors, and errors that occur during the problem-solving stage, such as encoding errors. The inability to answer the question and draw appropriate conclusions from work results are the two primary indicators of errors.

Higher Order Thinking Skills (HOTS)

The concept of High Order Thinking Skills refers to a cognitive process in which students engage in higher-level thinking. This process is developed through various mental concepts and methods, as well as learning taxonomies such as problem-solving methods, Bloom's taxonomy, and learning, teaching, and assessment taxonomies. High-order thinking skills comprise problem-solving, creative thinking, critical thinking, argumentative abilities, and decision- making abilities. According to Newman and Wehlage, high-order thinking skills involve critical, logical, reflective, metacognitive, and creative thinking. When students engage in high-order thinking, they can differentiate ideas, argue well, solve problems, explain constructs, hypothesize, and understand complex concepts. This is achieved when a person links new information with information already stored in their memory, reorganizes and compresses knowledge to achieve a goal or solve a problem. This highlights the significance of higher-level thinking in the learning process. The primary objective of high-order thinking skills is to enhance students' thinking abilities, particularly in critically analyzing various types of information. Statistics is a scientific discipline that involves the methods of collecting, processing, presenting, analyzing, and inferring data obtained from observation or research. The thinking framework for analyzing student errors in solving high-level thinking-type mathematics problems is based on Newman's error analysis theory. This theory identifies Reading Errors, Comprehension Errors, Transformation Errors, Processing Skill Error, and Encoding Errors as errors in writing final answers. This framework and its indicators can help identify which type of error students fall into based on Newman's thesis regarding HOTS-type questions given to students. The framework of thinking is illustrated below.



3. RESEARCH AND METHOD

As per Moleong (2011: 4), this study employed qualitative methods and descriptive case studies. These methods included analyzing written or verbal human expressions and observable behavioral data. Sugiyono (2005:21) defines descriptive qualitative research as a post-positivist research method frequently used to investigate natural and objective conditions where the researcher acts as a critical instrument. In this study, the research technique involved analyzing

existing cases to identify students' mistakes. It is crucial to analyze students' work results to identify their errors, especially when tackling higher-order thinking skills (HOTS) questions on challenging material. Moreover, examining the factors that lead to these mistakes is crucial.

The research design aims to analyze students' errors in answering mathematics questions on probability material that requires higher-order thinking skills (HOTS). The methodology includes the following steps: 1) Preparation of research tools such as questionnaires and interview guides. Test questions will be selected from the 2014 PISA based on statistical data.

The interview guide will be prepared based on Newman's error analysis theory, which includes reading, understanding, transformation, process skills, and final answer errors. 2) Proper selection of interview instruments and questions can reduce students' mistakes in answering questions based on Newman's theory. 3) Research subjects will be purposefully sampled by selecting Class VIII-A students and creating score ranges based on high, medium, and low criteria. 4) The students will receive test questions and proceed to work on them. 5) Face-to-face interviews will be conducted with research subjects and students to clarify student responses, analyze errors, and determine the underlying causes of those errors.

The data collected from these interviews and test results will then be analyzed using Newman's error analysis**.** The research technique used in this study involves analyzing existing cases to identify students' mistakes.

4. RESULT DISCUSSION

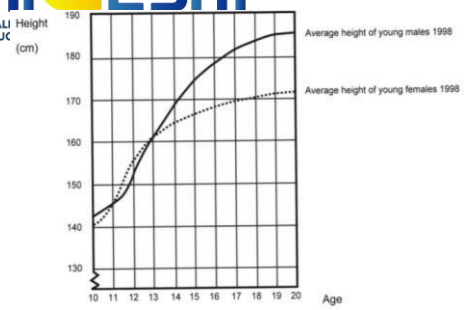
Explain the research results in the field that are in accordance with the problem formulated/studied in the introduction section. Results and discussion are separated (separate subtitle). All research must discuss findings using theory.

Four important points that must be implied/expressed in the results and discussion section are: (1) (what/how) the presented data has been processed (not raw data), presented in the form of a table or figure (choose one), The provided information is easy to understand and includes references to figures and tables. In the discussion section, a connection between the results and the basic concept is evident. Additionally, it is important to note any conformity or conflicts with the results of other research or studies. Finally, it is necessary to write about the theoretical and applied implications of the research results. The research process includes a planning stage where the researcher creates a written test instrument. This instrument consists of mathematical literacy questions with statistical material, taken from the 2014 PISA test.

Table 4.1

Details of student error categories on Question Number 1, using Newman's Theory Indicators,are listed below:

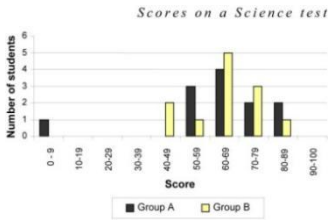
Question Number	Question Content	Error Indicator	Information (S) (S)
Question	In 1998, a graph was presented displaying the average height of young Dutch men and women..	a. Reading Errors	1) S- 01 2) S-02

	 Question 1 Since 1980 the average height of young women aged 20 years has increased an increase of 2.3 cm towards a height of 170.6 cm. What is the average height the body of a 20 year old teenage girl?		3) S-05 4) S-06 5) S-12 6) S-13 7) S-16 8) S-19
		b. Misunderstanding	1) S- 03 2) S- 07 3) S-08 4) S-09 5) S-10 6) S-18
		c. Error Information	1) S- 11 2) S- 17
		d. Process Skills Errors	1) S- 14
		e. Final Answer Writing Mistakes	1) S- 15
Question 2	Based on the graph above, which period/interval indicates adolescence girls aretaller than boys of the same age? Answer:	a. Reading Errors	1) S- 01 2) S- 08 3) S- 12 4) S- 13 5) S- 14 6) S- 15 7) S- 07

Question 3	Based on the graph above, which period/interval indicates adolescence girls aretaller than boys of the same age? Answer:	a. Reading Errors	1) S- 01 2) S- 02 3) S- 03 4) S- 05 5) S- 06 6) S- 07 7) S- 08 8) S- 12 9) S- 14 10) S- 18 11) S- 19

Source: Researcher

Tabel 4.2 Details of student error categories with Newman Theory indicators On Question Number 2

Number Question	Question Content	Error Indicator	Error IndicatorS)
question 1	The following diagram shows the results of the science test divided into two groups, namely group A and group B. The mean of group A is 62.0 and the mean of group B is 64.5. Students complete if they get a score above or equal to 50 .  The teacher conveyed that Group B performed better than Group A in the test, as indicated in the diagram. However, a student from Group A disagreed with the teacher's perspective and attempted to protest by stating that Group B's performance was not superior. To provide feedback, please utilize the diagram above and present mathematical evidence to support the student's argument from Group A.	a. Reading Errors	1) S- 01 2) S- 02 3) S- 04 4) S- 05 5) S- 08 6) S- 12 7) S- 13
		b. Misunderstanding	1) S- 03 2) S- 16 3) S- 19 4) S- 18
		c. Transformation Error	1) S- 06 2) S- 09 3) S- 10 4) S- 11
		d. ProcessSkills Errors	1) S- 15 2) S- 17
		e. Final Answer Writing Mistakes	1) S- 14

Source: Researcher

Tabel 4.3 Details of student error categories with Newman Theory indicators On Question Number 3

Number Question	Question Content	Error Indicator	Student Information (S)
Question 1	When sprinting, reaction time is the time	a. Reading	1) S- 06

<table>
<tr>
<td rowspan="2"></td>
<td rowspan="2">interval between the signal when the weapon is fired and the athlete leaves the starting block area. Final Time is calculated based on reaction time and running time. The following table showsthe reaction times and final times of 8 athletes running the 100 meter sprint distance.
<table>
<tr><th>Lane</th><th>Reaction Time (sec)</th><th>Final Time (sec)</th></tr>
<tr><td>1</td><td>0.147</td><td>10.09</td></tr>
<tr><td>2</td><td>0.136</td><td>9.99</td></tr>
<tr><td>3</td><td>0.197</td><td>9.87</td></tr>
<tr><td>4</td><td>0.180</td><td>Did not finish the race</td></tr>
<tr><td>5</td><td>0.210</td><td>10.17</td></tr>
<tr><td>6</td><td>0.216</td><td>10.04</td></tr>
<tr><td>7</td><td>0.174</td><td>10.08</td></tr>
<tr><td>8</td><td>0.193</td><td>10.13</td></tr>
</table>
Question 1: Determine which runner is entitled to a gold, silver and bronze medal from this competition. Fill in the following table along with lane number, reaction time and final time</td>
<td>Errors</td>
<td>2) S- 12
3) S- 15
4) S- 18
5) S-19</td>
</tr>
<tr>
<td>b. Process Skills Errors</td>
<td>1) S- 01
2) S- 02
3) S- 03
4) S- 04
5) S- 05
6) S- 07
7) S- 08
8) S- 09
9) S- 10
10) S- 11
11) S- 13
12) S- 14
13) S- 16
14) S- 17</td>
</tr>
<tr>
<td rowspan="2">Question n 2</td>
<td rowspan="2">In athletic competitions, a runner must reach the starting line within 0.110 seconds of the gun firing. If their recorded reaction time is less than this, it is considered a false start as they left the block before hearing the gunshot. If the bronze medalist has the fastest reaction time, do they have a chance to win the silver medal? Please provide an explanation to support youranswer.
.</td>
<td>a. Reading error</td>
<td>1) S- 02
2) S- 10
3) S- 11
4) S- 12
5) S- 13</td>
</tr>
<tr>
<td>b. Transformation Error</td>
<td>1) S- 04
2) S- 05
3) S- 06
4) S- 07
5) S- 08
6) S- 09
7) S- 15
8) S- 17
9) S- 18
10) S- 19</td>
</tr>
</table>

Source: Researcher

Interview

Please refer to the diagram provided. According to the teacher, Group B performed better than Group A in the test. However, a student from Group A disagrees with this opinion and has protested that Group B is not actually better. To support the students from Group A, please provide mathematical comments using the diagram.

5. CONCLUSION

After analyzing the research results and focusing on the statistics material, the following conclusions can be drawn regarding the types of errors made by students when solving HOTS-

type mathematics questions.

1. For Question 1, students make reading errors, understanding errors, transformation errors, mistakes in process skills, and errors in the final answer.

2. The reason for reading errors is that students need to be more careful when reading the questions. Additionally, students need to improve their ability to understand literacy questions. Understanding errors occur because students tend to rush to find answers without fully comprehending the question.

Transformation errors occur because students find it challenging to determine which method to use. Story questions, which are mathematical literacy-type questions, can contribute to process skill errors because they can make students careless and rushed. To solve these questions, students must find the correct procedure to use. Mistakes in writing the final answer occur because students need to understand what is being asked to write the correct answer. Furthermore, literacy questions can be challenging to understand.

Suggestion

To address the mistakes students make when solving HOTS-type (High Order Thinking Skills) questions in statistics, several considerations can be taken. Firstly, learning methods that improve problem-solving abilities related to everyday life and contextual issues should be implemented. Secondly, varied questions should be posed to trigger students to come up with creative ideas. Lastly, students should be trained to solve HOTS questions carefully to minimize mistakes and improve their thinking abilities. Additionally, HOTS-type questions can be used as a comparison and reference material for further research by prioritizing them.

6. REFERENCES

Kurnia, L., & Yuspriyati, D. N. (2020). Analysis of Middle School Students' Difficulties in Solving Social Arithmetic Problems Based on Newman's Analysis. Journal of Pedagogic Mathematics, Vol 4.

Moleong, L. J. (2011). Qualitative Research Methodology. Bandung: PT Teen Rosdakarya.

Rini Yulia, Fauzi, Awaluddin. (2017). Analysis of Student Errors Working on Mathematics Problems in Class V Sdn 37 Banda Aceh.

Scientific Journal of Elementary School Teacher Education FKIP Unsyiah, Vol 2 (1):124- 131.

Saputra, Hatta. (2016). Development of Education Quality Towards the Global Era: Strengthening Learning Quality by Implementing HOTS (High Order Thinking Skills). Bandung: SMILE's Publishing.

Suharsono, & Retnoningsih, A. (2012). Big Indonesian Dictionary. Semarang: Widya Karya.

Sugiyono. 2005. Understanding Qualitative Research. Bandung: Alphabeta.

Widodo, T & Kadarwati, S. (2013). High Order Thinking Based on Problem-Solving to Improve Student Character Building-Oriented Learning Outcomes. Educational Horizons Vol 32 (1): 161 171.

Yasmin, E. (2016). Students' Learning Difficulties in Mathematics Lessons (Summary with a Metethnography Approach). Journal of Educational Science Vision, Vol 9 (1): 2119–2136.