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Kesalahan Siswa Menyelesaikan Soal Pola Bilangan, Barisan, dan Deret Tipe HOTS Berdasarkan Teori Newman Ditinjau dari Gender

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Abstrak

Penelitian ini memiliki tujuan untuk menganalisis kesalahan-kesalahan siswa yang kemampuan HOTS pada tingkat tinggi, sedang dan rendah serta mengidentifikasi kesalahan siswa dalam menyelesaikan soal tipe HOTS (*Higher Order Thinking Skill*) ditinjau dari gender. Jenis penelitian yang dilakukan adalah kualitatif dengan pendekatan studi kasus. Subjek penelitian dipilih 3 siswa laki-laki dan 3 siswa perempuan, yang masing-masing tingkat kemampuan HOTS tinggi, sedang dan rendah terdiri dari 2 siswa. Teknik pengumpulan data menggunakan tes bertipe HOTS dan wawancara. Kerangka analisis dikembangkan berdasarkan kategori kesalahan teori Newman. Data yang diperoleh diuji keabsahannya melalui uji kredibilitas, *transferability*, *dependability*, dan *konfirmability*. Hasil penelitian menunjukkan terdapat beberapa perbedaan jenis dan besar persentase kesalahan yang dilakukan oleh subjek laki-laki dan perempuan dalam menyelesaikan soal tipe HOTS. Kesalahan terbesar yang dilakukan kedua gender pada materi pola bilangan, barisan, dan deret yaitu kesalahan memahami sebesar 33,33%, kemudian diikuti kesalahan penentuan jawaban akhir sebesar 23,02%, kesalahan transformasi sebesar 22,22%, kesalahan proses penyelesaian sebesar 20,63%, dan terakhir kesalahan membaca sekitar 0,79%. Terlihat bahwa gender perempuan lebih banyak melakukan kesalahan sebesar 57.14% dibandingkan dengan gender laki-laki sebesar 41.86%.

Kata Kunci: gender, HOTS, teori Newman.

Student Errors in Solving Number Patterns, Sequences, and Series HOTS Types Based on Newman's Theory in Terms of Gender

Abstract

This study aims to analyze the errors of students with HOTS abilities at high, medium and low levels and identify student errors in solving HOTS (Higher Order Thinking Skill) type questions in terms of gender. This type of research is qualitative with a case study approach. The research subjects were selected 3 male students and 3 female students, each of which the HOTS ability level was high, medium and low consisting of 2 students. Data collection techniques used HOTS-type tests and interviews. The analytical framework was developed based on Newman's theory of error categories. The data obtained were tested for validity through credibility, transferability, dependability, and confirmability tests. The results showed several differences in the types and percentages of errors made by male and female subjects in solving HOTS-type questions. The biggest mistakes made by both genders in the material of number patterns, sequences, and series are misunderstandings of 33.33%, followed by errors in determining the final answer of 23.02%, transformation errors of 22.22%, errors in the completion process of 20.63%, and finally, reading errors of 0.79%. It can be seen that the female gender makes more mistakes by 57.14% compared to the male gender by 41.86%.

***Keywords**: gender; HOTS; Newman's theory*

INTRODUCTION

The development of science and technology in the global era has made an extraordinary breakthrough for some people. The development of students' mindsets is a demand that must be prepared to face the global era (Rahzianta, 2016). This is in line with the Partnership of 21st Century Skills which requires 21st-century students to be able to focus on developing higher-order thinking skills. In sync with Anderson & Krathwohl (Anderson & Krathwohl, 2010; Mangangantung & Tuerah, 2021; Saraswati & Agustika, 2020), HOTS students will be accustomed to thinking critically and creatively both in argument, decision making, and problem-solving related to analyzing, evaluating and creating.

Problem-solving uses the basic thought process to solve known or defined difficulties, collects facts about these difficulties, and determines additional information needed. HOTS can be produced through problem-solving activities both in everyday life and in the classroom (Nadapdap; & Istiyono, 2017). According to Astuti & Adirakasiwi (2019), the results of the PISA international study can be used as a benchmark for the government to make better strategies to improve the achievement of Indonesian students' mathematical competencies rise from the positions that have been achieved. One of the efforts to develop skills in solving HOTS questions is to manage HOTS-oriented learning through problem-solving activities.

One of the mental action activities for solving problems is by doing HOTS-type questions. According to Lester & Kehle, problem-solving activities involve various mental actions, including accessing and using knowledge and experience (Lester, 2007; Prayekti et al., 2020; Susanti et al., 2019). Furthermore, in the mathematics curriculum, problem-solving is a crucial part. Students will gain experience using the knowledge and skills needed to be applied to non-routine problem solving (Widodo & Turmudi, 2017). Solving problems with non-routine situations is a characteristic of HOTS-type questions. So that in its application, solving HOTS-type questions can be solved through mental problem-solving actions.

HOTS developed from Bloom's taxonomy includes students' abilities or skills in analyzing (C4), evaluating (C5), and creating (C6). According to Harel (2011), analyzing, evaluating, and creating is a mental act of problem-solving. These mental acts are the essential elements of human cognition. These mental actions will form a flow of thought that forms ways of thinking (WoT), leading to the formation of ways of understanding (WoU). New ideas and breakthroughs regarding the pedagogical definition of mathematics, namely learning mathematics that, involves two stimuli for the formation of WoU and WoT.

With the high cognitive level that is an indicator of HOTS, students may experience errors in solving HOTS-type questions. Research on error analysis in solving HOTS-type questions conducted by Abdullah et al. (2015) states that errors analyzed according to Newman's error analysis model consist of reading, understanding, transformation, process skills, and coding. Research concluded that the application of Newman Error's Analysis (NEA) in solving math story problems is a powerful tool in assessing and analyzing student difficulties or problems during the problem-solving process (Amin Suyitno, 2015; Chiphambo & Mtsi, 2021; Karnasih, 2015).

Several error theories exist according to the views of experts, one of the error theories that has attracted the attention of researchers is Newman's theory. According to Newman (Newman, 1977, 1983; Silvia et al., 2020), errors in doing math problems are divided into five types of errors, namely: (1) reading error, which occurs because students misread the primary information given by the question so that in working on the problem and student answers do not match the purpose of the question; (2) comprehension error; students have not taken mental actions to understand the right, students do not know what is being asked in the question; (3) transformation error is an error that occurs because students have not been able to change the problem into a mathematical model correctly; (4) process skills error, occurs because students are not yet skilled in making calculations; (5) encoding error is an error in the completion process.

The gender factor allows for differences in errors in solving HOTS-type questions. This is supported by research conducted by Mulyani & Muhtadi (2019) using Newman's theory of errors was found in solving HOTS-type questions, namely that the female gender made fewer mistakes at the

transformation stage than the male gender and the female gender made mistakes at the comprehension, process skill, and encoding stages more than the male gender.

This is also experienced by some of the students in class VIII at one of the State Madrasah Tsanawiyah schools in Medan City. The educator who taught the class revealed that some students made mistakes in solving math story problems, one of which was in the material on number patterns, sequences, and series. This material requires various methods of completion, so it requires high problem-solving skills or high order thinking skills (HOTS) to solve the given problems (Maryati & Fadhilah, 2021).

Various causes of errors were found in students in solving number pattern problems, sequences, and series. One of them is caused by the inability of students to recall the solving procedures carried out by the teacher because students only copy problem-solving procedures from the teacher (Hariyani, 2018). This is because students consider the teacher's problem-solving procedure as the most appropriate solution. Problem-solving patterns of numbers, sequences, and series tend to be monotonous. New problem solving is easier if the procedure refers to solving problems that have already been solved (Wareham et al., 2011). Therefore, to find out the reasons that cause students to make mistakes in understanding number patterns, sequences, and series questions in the form of story questions, it is necessary to analyze students' errors in working on questions.

Based on the problems described, researchers are interested in conducting research that aims to analyze student errors in solving patterns of numbers, sequences, and series of Higher Order Thinking Skill (HOTS) types based on Newman's error category in terms of gender.

METHOD

Based on the problems studied, this study uses qualitative research methods. This method describes students' errors in solving story-shaped questions regarding gender. This research design will use a case study that aims to describe, evaluate, or explain the phenomenon of student errors in solving story-shaped questions in terms of gender (Borg, 2014).

In the odd semester of the 2021/2022 academic year, the research was conducted on eighth grade students of one of the Medan City State Madrasah Tsanawiyah. The research subjects consisted of 3 male and 3 female students, each of which consisted of 2 students with high abilities, medium, and low. The selection of research subjects was based on the results of the daily assessment of the previous material and the consideration of the mathematics subject teacher at the school.

Table 1. Student Error Indicators by Newman Analysis Category

No.	Newman Error Analysis	Error Indicator	Points
1.	Reading	• Cannot interpret words that are considered difficult to propose.	1
2.	Comprehension	• Does not write down what is known and cannot explain the problem implicitly. • Does not write down what is asked and cannot explain the question's meaning. • Write down what is known with self-made and unscripted symbols. • Write down the question asked briefly so that it is not clear. • Writing down the question is not under what is asked in the question.	5
3.	Transformation	• Does not convert information on a problem into mathematical sentences and cannot explain the process of change. • Converts the information on the problem into mathematical sentences but is not precise.	2
4.	Process skill	• Errors in computing. • Cannot explain the computational process in an answer sheet. • Does not continue the settlement procedure.	3
5.	Encoding	• Not writing an answer. • Write an incorrect answer. • Write answers that do not fit the context of the problem. • Does not include the appropriate units.	4

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The instrument used in this study was a 3-item description test of the HOTS (Higher Order Thinking Skill) type with material on number patterns, sequences, and series and unstructured interviews. The steps for collecting this data are (1) making test questions based on the HOTS (Higher Order Thinking Skills) category, (2) validating test questions, (3) distributing test questions to class VIII Madrasah Tsanawiyah Negeri Medan City students, (4) supervising students in working on test questions, (5) collecting student answer sheets, (6) Checking student answer sheets, and (7) based on student test results, the researcher chose 6 students to be investigated in more detail.

To find out the errors made by students in Mulyani & Muhtadi (2019), the data obtained were analyzed based on Newman's error guidelines with indicators as presented in Table 1.

Newman's error guidelines in the table are set so that when analyzing student answer sheets, each student's error for each question can be categorized according to the error indicator. Each student who makes a mistake in solving the HOTS questions will get points that will later determine the error level for each type of error. To determine the error rate, the percentage of errors (E) made by students is sought for each type of error. Furthermore, the level of errors made by students is determined by referring to the criteria for the percentage level of error set in (Ariyunita, 2012), as shown in Table 2.

Table 2. Student Error Presentation Level Criteria Guidelines

No.	Interval	Rate
1.	$0\ percent \leq e\ < 20\ percent$	Very Low Error
2.	$20\ percent \leq e\ < 40\ percent$	Low Error
3.	$40\ percent \leq e\ < 60\ percent$	Enough Error
4.	$60\ percent \leq e\ < 80\ percent$	High Error
5.	$80\ percent \leq e\ \leq 100\ percent$	Very High Error

The validity of the data is an important part of a study. “To determine the validity of the data, an examination technique is needed based on several certain criteria. There are four criteria used, namely the criteria for credibility, transferability, dependability, and confirmability” (Moleong, 2018; Nassaji, 2020)

Credibility or trust is the compatibility between the author's and respondent's concepts. These criteria can be checked by extending participation, the persistence of observation, triangulation, peer checking, referential adequacy, and member checking. Transferability is if the results of qualitative research can be used or applied to other cases or situations. Examining these criteria is done by compiling detailed, clear, systematic, and reliable research reports. Dependability or dependability is a criterion for qualitative research, whether the research process is quality or not. Examining these criteria is done by conducting examinations during the overall research process, assisted by supervisors. In qualitative research, confirmability criteria are similar to dependability criteria so that the checks can be carried out simultaneously. Research is said to be objective if many people agree on the results. Examination of these criteria is carried out by examining the objectivity of the results of the analysis of data findings and research discussions.

RESULTS AND DISCUSSION

After conducting research and analyzing the test results data for 6 students, it can be seen that students still make many mistakes in solving HOTS-type questions on the material of number patterns, sequences, and series. The test questions consisted of 3 questions in the form of descriptions related to the application of number patterns, sequences, and series. Table 3 presents student work data analyzed based on the type of Newman error based on the numbering of items.

Table 3. Student Error Indicators Based on Newman's Analytical Procedures
(Based on Problem Item Numbering)

No.	Stages	Problem Number						Σ	Percentage (%)	Error Rate
		1	%	2	%	3	%			
1.	Reading	0	0	0	0	1	2.13	1	**0.79**	Very Low
2.	*Comprehen-sion*	14	38.89	12	27.91	16	34.04	42	**33.33**	Low
3.	Transforma-tion	8	22.22	8	18.60	12	25.53	28	**22.22**	Low
4.	Process skill	8	22.22	10	23.26	8	17.02	26	**20.63**	Low
5.	Encoding	6	16.67	13	30.23	10	21.28	29	**23.02**	Low

The following are the results of the research and discussion of each step according to the Newman procedure of all students studied, which are presented in table 4.

Table 4. Student Error Indicators Based on Newman's Analytical Procedures
(All Students Examined on Every Problem Number)

Newman Error Analysis	Error Indicator	MHAS			FHAS			MMAS			FMAS			MLAS			FLAS		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Reading	1A	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	v
	2A	x	v	v	x	x	x	x	x	x	v	v	v	v	v	v	v	x	v
	2B	x	x	x	x	x	x	x	x	x	v	v	v	x	x	x	v	v	v
Comprehension	2C	v	v	v	x	x	x	v	x	x	v	v	v	v	v	v	v	x	v
	2D	x	x	v	x	x	x	x	x	x	v	v	v	v	x	v	v	v	v
	2E	x	x	v	x	x	x	x	x	x	x	v	x	x	x	x	v	v	v
Transformation	3A	x	x	v	x	x	v	v	v	v	v	v	v	v	v	v	v	v	v
	3B	x	x	v	x	x	v	v	v	v	v	v	v	v	v	v	v	v	v
Process skill	4A	v	x	v	x	x	x	x	v	x	x	v	v	v	v	x	v	v	v
	4B	v	x	v	x	x	x	x	v	x	v	v	v	v	v	x	v	v	v
	4C	x	x	v	x	x	x	x	x	x	x	v	x	x	v	x	v	x	v
Encoding	5A	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	v
	5B	x	x	v	x	x	x	x	v	x	x	v	v	x	v	x	v	v	v
	5C	x	x	x	x	x	x	x	v	x	x	v	v	x	v	x	v	v	v
	5D	x	v	v	x	x	x	v	v	v	v	v	v	v	v	x	v	v	v

From table 4, it is determined that x is made no mistake; v is making a mistake; MHAS is Male High Ability Students; FHAS is Female High Ability Students; MMAS is Male Medium Ability Students; FMAS is Female Moderate Ability Students; MLAS is Male Low Ability Students; FLAS is Female Low Ability Students

From the student worksheets, the error analysis obtained is that students from the high ability group make mistakes by not writing down what they know and are asked about in the questions but can still understand the concept strategies that will be used in solving the problems. Moderate and low-ability students, on average, made the same mistake, namely not writing down what they knew and asking the question. However, the difference between high ability students, namely moderate and low ability students, there are still those who do not understand especially concepts. Students are not used to understanding story problems, so translating the information into the questions is still difficult. Students are still confused about writing the shape of the pattern formed from the problem so that the line or series is not formed correctly.

The following are the analysis results of students' answer sheets in solving HOTS-type questions.

1. High Ability Male Students

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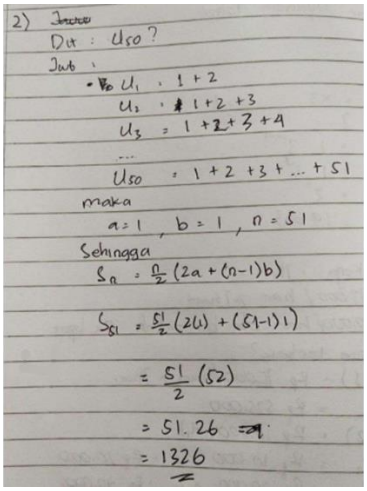

Figure 1. Work Results of High Ability Male Students

The picture above shows that the student made a mistake by not including the points known from the question, but the other steps were complete. After the interview, the student's answers are known to have been in the questions.

2. High Ability Female Students

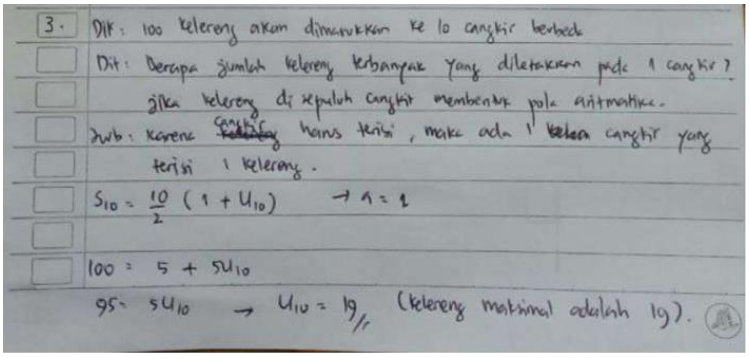

Figure 2. Work Results of High Ability Female Students

From the picture above, it can be seen that the student made an error by not changing the information asked in the question into a mathematical sentence and could not explain the process of change. Whereas students can write down what is asked by changing the information from the question to U_n. After the interview, the students' answers did not focus too much on converting information into mathematical sentences but on what strategies could solve the problem.

3. Medium Ability Male Students

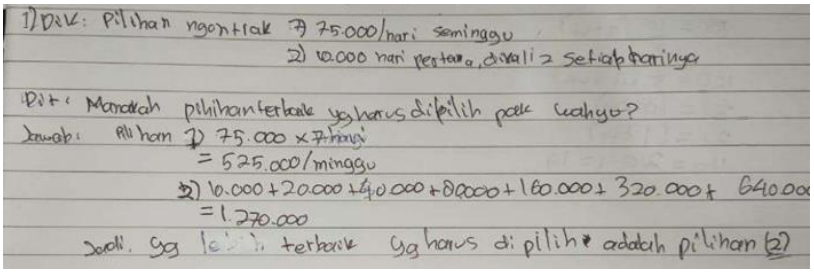

Figure 3. Work Results of Male Medium Ability Students

From the picture above, it can be seen that students made an error, not including the appropriate unit. The unit that should be included is Rupiah because the question requires students to analyze options (1) or (2) which Pak Wahyu should choose to get the enormous salary. After the interview, the

student's answers were forgetful and careless because they were in a hurry. Careless errors relate to unintentional but avoidable procedures students perform during problem-solving.

4. Medium Ability Female Students

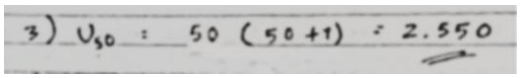

Figure 4. Work Results of Female Medium Ability Students

From the picture above, it can be seen that students make mistakes not knowing what is known and asked in the questions and make mistakes in reducing the information contained in the questions and choosing the information needed in formulating data to solve problems. This causes students to write answers that are not under the context of the question. After the interview, the students said they could not understand the question.

5. Low Ability Male Students

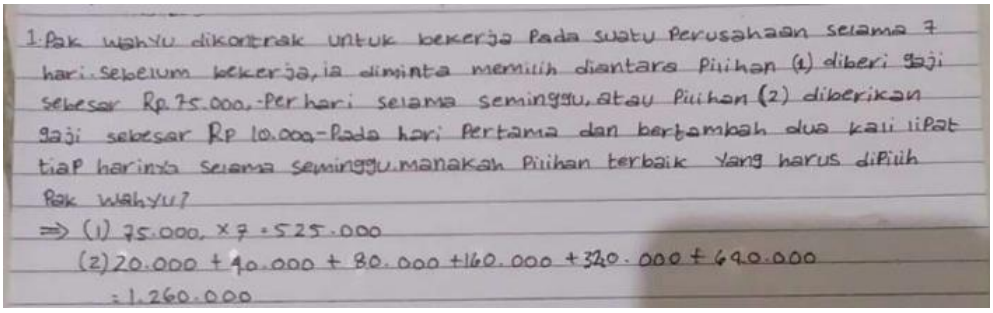

Figure 5. Work Results of Low-Ability Male Students

From the picture above, it can be seen that students make mistakes in computing. The error in the computation starts from Rp.160,000 x 2 = Rp.320,000 but the student's computational result is Rp.340,000. This resulted in less appropriate answers to the results of problem-solving written by students. After the interview, the student's answer was careless, and he did not double-check. Checking back or looking back is the last step in solving mathematical problems (Suarsana et al., 2019). In this step, students review the problem or solution that has been computed.

6. Low Ability Female Students

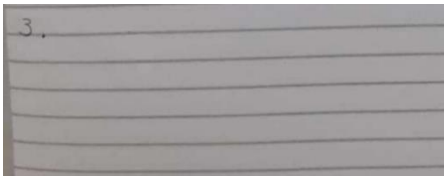

Figure 6. Work Results of Low Ability Female Students

From the picture above, it can be seen that students make mistakes in not being able to read/interpret words that are considered problematic, which are posed in the questions so that students cannot write down what is known and asked. This results in students being unable to know what strategies are appropriate to solve problems. After the interview, the student answered that when the teacher explained the material on number patterns, sequences, and series, the students admitted that they ignored the teacher. In solving mathematical problems, especially in solving non-routine questions such as HOTS-type questions, students need scaffolding that is relevant and timely for the learning process that goes well (Haataja et al., 2019).

Table 5 below presents the data from the student answer sheets, which were analyzed based on the Newman error category based on students' abilities.

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Table 5. Student Error Analysis by Newman Analysis Category (Reviewed from student ability)

No.	Stages	Student ability		
		High	**Medium**	**Low**
1.	Reading	0	0	1
2.	*Comprehension*	7	14	21
3.	Transformation	4	12	12
4.	Process skill	5	8	13
5.	Encoding	3	12	14
	Sum	**19**	**46**	**61**
	Percentage (%)	**15.08**	**36.51**	**48.41**
	Error Rate	**Very Low**	**Low**	**Enough**

From Table 5 it is found that students with low abilities have the most significant percentage of errors based on Newman's analytical procedures. Low ability students are 48.41% with a sufficient error rate, medium ability students are 36.51% with a low error rate, and high ability students are 15.08% with a meager error rate.

Table 6. Student Error Analysis by Newman Analysis Category (Reviewed from the student's gender)

No.	Stages	Gender				∑
		Male	**%**	**Female**	**%**	
1.	Reading	0	0	1	0.79	1
2.	*Comprehension*	16	12.70	26	20.63	42
3.	Transformation	14	11.11	14	11.11	28
4.	Process skill	12	9.52	14	11.11	26
5.	Encoding	12	9.52	17	13.49	29
	Sum	54	**42.86**	72	**57.14**	126

Table 6 shows the percentage for each type of student error in solving HOTS-type questions on the material of number patterns, sequences, and series in terms of the overall ability level of students at each stage Newman has an error rate between very low and low. It can be seen that the female gender makes more mistakes by 57.14% compared to the male gender making mistakes by 41.86%. In line with research Siswandi et al. (2016) that the male gender is slightly superior in solving contextual math problems to the female gender, this can be seen from the types of male errors in general, namely transformation errors, the completion process (process skills error), and an error in determining the final answer (encoding error). Meanwhile, the types of errors made by women were mostly comprehension errors, transformation, process skills, and encoding.

CONCLUSION

The results showed differences in the types of errors made by male and female gender in solving HOTS type questions. The biggest mistakes made by students were understanding errors of 33.33%, then followed by errors in determining the final answer of 23.02%, transformation errors of 22.22%, completion process errors of 20.63%, and finally reading errors of 0,79%. It can be seen that the female gender makes more mistakes by 57.14% compared to the male gender making mistakes by 41.86%. The female gender made more mistakes at the reading, comprehension, process skill, and encoding stages than the male gender. Meanwhile, for the transformation stage, both female and male gender have the same error percentage, 11.11%. Students make these mistakes in general because students are not familiar with HOTS questions or non-routine questions, do not remember the concepts pattern of numbers, sequences, and series that have been studied which are needed in solving problems, students tend to memorize formulas or a concept without understanding the meaning of the formulas and concepts so that when the questions When applied to non-routine forms, students experience being overwhelmed, besides that students are not careful and in a hurry to work on

questions, tend to answer questions briefly. Students have difficulty building ideas or ideas and get stuck in ideas in working on questions.

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