

Improving Student's Reflective Thinking Skills Through Realistic Mathematics Education Approach

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Abstract—This research is motivated by the importance of reflective thinking skills by applying the Realistic Mathematics Education (RME) approach. The purpose of this research to improve reflective thinking skills through the Realistic Mathematics Education (RME) approach and determine students' mistakes in reflective thinking skills. The method used is mixed methods with the incorporation of quantitative-qualitative design. The sample in this research consisted of eighth graders in a state junior high school in Serang, Indonesia, involving two classes, namely the experimental class, and the control class. The instruments used in the form of reflective thinking skills test instruments, non-test instruments in the form of observation sheets, documentation and researchers. The conclusion from this study that the reflective thinking skills of the experimental class are better than the control class. Student mistakes in taking reflective thinking tests include errors in making mathematical modeling, concept errors, systematic errors, and miscalculations.

Keywords: *reflective thinking skills, realistic mathematics education*

I. INTRODUCTION

Law No. 20 of 2003 concerning the National Education System has the vision of realizing the education system as a strong and authoritative social institution to empower all Indonesian citizens to become qualified human beings so that they are able and proactively to respond to the challenges of an ever-changing era. Human quality is produced through the implementation of quality education. Therefore, changes need to be made in the field of education. Among these changes, namely in the learning process in the classroom, initially, teacher-centered learning turned to student-centered, initially the teacher as an expert switched students as experts, initially the passive classroom activities became active.

Reflective thinking is meaningful thinking, which is based on reason and purpose. This is a type of thinking that involves problem-solving, formulation of conclusions, and making decisions when one uses skills that are meaningful and effective for a particular context and the type of task thinking, by reflecting, students can develop high-level thinking skills through encouragement to linking new knowledge to their previous understanding, thinking in abstract and concrete

terminology, applying specific strategies to new tasks, and understanding their thought processes and learning strategies. This reflective thinking is intended to improve high-level thinking skills [1].

The importance of reflective thinking skills has not been matched by facts related to students' reflective thinking abilities. Based on a preliminary study in one of the high schools in the Tangerang Regency of Banten Province, each indicator of the ability to reflect reflectively has not shown satisfactory results. Nearly 60% of students have not shown satisfactory results in working on questions that contain indicators of mathematical reflective thinking processes [2]. This shows that the reflective thinking process is not yet accustomed to students and is rarely used by teachers to be given. The problem with mathematical reflective thinking must be addressed immediately, given the importance of mathematical reflective thinking skills in developing high-level mathematical thinking skills, mathematical critical thinking, and creativity that are useful in learning success.

Based on the explanation above, one of the possible approaches to improve reflective thinking skills is the RME approach. According to Freudenthal "Mathematics is a human activity". This became the basis for realistic mathematics education. Realistic Mathematics Education (RME) is an approach to learning mathematics that provides realistic problems. Realistic problems do not have to be problems that exist in the real world and can be found in the daily lives of students, but a problem is said to be "realistic" if the problem can be imagined or manifest in the minds of students [3].

Characteristics of the RME approach are, a) Learning must start from problems taken from the real world, b) Abstract and real worlds must be bridged by models, c) Students have the freedom to express their work in solving real problems given teacher, d) The learning process must be interactive [4]. This argues that reflective thinking is active, continuous, persistent, and carefully considers everything that is believed to be true or the format of knowledge with reasons that support it and leads to a conclusion. With interactive learning, students will express themselves more expressively, can solve the problems they face so that students' reflective thinking can be better than conventional learning [5].

From the opinions above, it can be concluded that RME is a learning approach in mathematics education that is based on the idea that mathematics is a human activity and mathematics must be related significantly to the context of students' daily lives as a source of development and as an application area through processes mathematically both horizontally and vertically. In other words, RME is an approach in learning mathematics by relating mathematical concepts to real life. If this is done, the reflective abilities of students are expected to increase because students will more easily solve mathematical problems even without the concrete objects of the problem.

Based on the description above, a study was conducted entitled **"Improving Students' Reflective Thinking Skills Through Realistic Mathematics Education Approach "**.

The purpose of this study is to: (a) Investigate, know, and describe the final achievement and increase the ability of reflective thinking students who get learning with the Realistic Mathematics Education (RME) approach and students who get conventional learning and investigate what errors are found in completion test the reflective thinking skills students make on the material under study.

II. RESEARCH METHODS

The research methods used in this research are mixed methods. Data on achievement and enhancement of reflective thinking skills will be described in detail with the support of qualitative data. The research design used is concurrent embedded design with quantitative methods as primary methods and qualitative methods as methods embedded into the primary method [6].

The quantitative research design used is a non-equivalent control group design. In this design, the experimental class and the control class are not randomly selected. Both classes were given a pretest (O) to find out the initial state, then given treatment according to the class, where the experimental group received special treatment (X), then the two groups were given posttest (O) to find out the final achievement of the two classes. In short, the design of this study can be seen as follows [7].

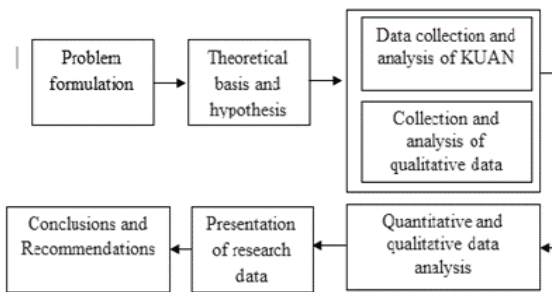


Fig. 1. Mixed methods.

Description:

X : learning using the RME strategy

- O : giving pretest and posttest the reflective thinking skills
- : Samples are not randomly selected

The subjects in this study were all class VIII students of SMP Negeri 4 Kota Serang consisting of 9 classes. The selection of class VIII is based on several considerations, including the VIII grade students who are considered able to adapt to the school environment, easy to accept new things in learning, easily directed, and are considered to have a basic mathematical concept. Samples in this study were taken through cluster sampling techniques, namely random sampling based on groups, not based on members. The drawing results obtained that the experimental class is class VIII C and the control class is class VIII B.

III. RESULTS AND DISCUSSION

A. Results

1) *Early students' reflective thinking skills:* This study begins by giving questions about reflective thinking skills. Pretest consists of 5 questions with a maximum score of 40 that have been tested before and given time for 80 minutes. To find a clear picture of the pretest data then first do a descriptive analysis. Descriptive statistics about the pretest scores of the experimental class and control class can be seen in Table 1 below:

TABLE I. DESCRIPTIVE STATISTICS DATA PRETEST

Class	Experiment	Control
Total data	39	39
Minimum	2	2
Maximum	24	28
Average	13.18	14.20
Std.Deviation	6.15	6.99
Variance	40.25	57.62

Based on the table above it can be seen that the average results of the pretest of the experimental class and the control class were not significantly different, namely 13.18 and 14.20 with a difference of 1.02. The standard deviation and variance of the control class are greater than the experimental class, this shows that the distribution of the control class scores is more diverse than the experimental class. This gives the meaning that in descriptive statistics, the initial of reflective thinking skills in both classes have no significant difference. The average score of the experimental class pretest and control class can be seen in the following figure 2:

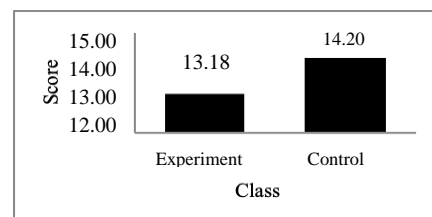


Fig. 2. Average pretest score.

C

Furthermore, inferential analysis is carried out to conclude whether there is a difference between the initial of reflective thinking skills in the experimental class students and the control class. Analysis of pretest data in this study consisted of prerequisite tests and continued with the *Mann-Whitney* test to obtain conclusions.

After a prerequisite test was carried out, the calculation continued with the *Mann-Whitney* test. The results of the *Mann-Whitney* test calculation can be seen in the following table 2:

TABLE II. MANN-WHITNEY PRETEST DATA

Types of Test	Statistic	Decisions
Mann-Whitney	$Z_{count} = 0.07$	There is no difference in
	$Z_{table} = 1.96$	

Table 2 produces a value of $0.07 < 1.96$ meaning $Z_{count} < Z_{table}$. This means that there is no difference in the average initial ability of reflective thinking between the experimental class and the control class.

2) *Achieving the end of students' reflective thinking skills:* This research was ended by giving a question about the reflective thinking skills. Postes consists of 5 questions which are the same as the pretest questions and the time given for 80 minutes. Descriptive statistics about the posttest scores of the experimental class and control class can be seen in Table 3 below.

TABLE III. DESCRIPTIVE STATISTICS OF POSTES DATA

Class	Experiment	Control
Amount of data	39	39
Minimum	18	16
Maximum	38	37
Average	29.82	27.95
Std. Deviation	4.47	4.78
Variance	15.96	24.83

Based on the table 3 above it can be seen that the average post-test results the experimental class 29.82 while the control class 27.95 with a difference of 1.78. The standard deviation and variance of the control class are greater than the experimental class but the posttest score of the experimental class is more diverse than the control class. It appears that based on descriptive statistics the average student of the experimental class is greater than the average of the control class students.

The average posttest score of the experimental class and the control class has differences, we can see in the following figure 3:

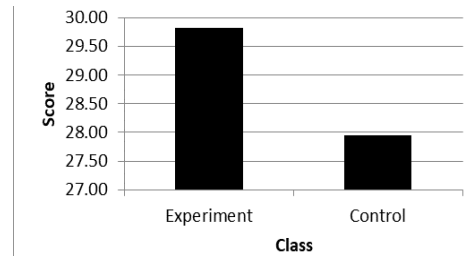


Fig. 3. Average postes score.

Furthermore, the inferential analysis was conducted to obtain conclusions on whether the final achievement of the reflective thinking skills in experimental class students was better than the control class. Analysis of posttest data in this study consisted of prerequisite tests and continued with two different test averages to obtain conclusions.

After a prerequisite test was carried out, the calculation continued with the test *Mann-Whitney*. The results of the test calculation *Mann-Whitney* can be seen in the following table 4:

TABLE IV. MANN-WHITNEY POST-DATA

Type of Test	Statistics	Decision
Test-t	$t_{count} = 2.26$	There are differences in abilities
	$t_{table} = 1.99$	

The table 4 above produces a value of $2.26 > 1.99$ shows that the value of $t_{count} > t_{table}$ that is. This means that there are differences in reflective thinking skills between the experimental class and the control class. Where the experimental class's reflective thinking skills is better than the control class.

3) *Categorization final achievement the reflective thinking skills:* The results of the experimental class's reflective thinking skills and control are categorized into three classes, namely high-class, middle-class, and low-class students. The student category results are presented in the following figure 4:

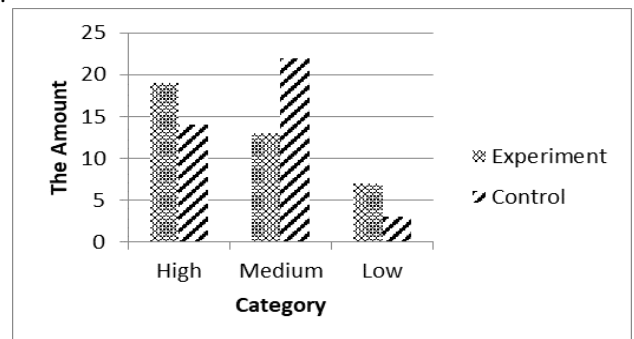


Fig. 4. Postes categorization.

From the figure 4 above it can be seen that in the experimental class, more students are in the high category while in the control class more students are in the medium category. This shows that the experimental class posttest score

spreads more in the high category while the control class posttest score spreads more in the low category.

4) *Increased of students reflective thinking skills:* The improvement of the reflective thinking skills in the experimental and control classes was processed using descriptive statistics so that the average, standard deviation, variance, highest and lowest scores were obtained. The data used is the data gain. Descriptive statistics about the increase in the experimental class reflective thinking skills and control class can be seen in the table 5 below.

TABLE V. DESCRIPTIVE STATISTICS DATA ON INCREASE REFLECTIVE THINKING SKILLS

Class	Experiment	Control
Number of data	39	39
Minimum	0.32	0.31
Maximum	0.89	0.82
Average	0.65	0.58
Std. Deviation	0.13	0.13
Variance of	0.02	0.02

Based on the table 5 above it can be seen that the average increase in reflective thinking skills experimental class 0.65 and control class 0.58 with a difference of 0.07. The standard deviation and variance of the experimental class and the control class are not too different, this shows that the distribution of the increase in reflective thinking skills from the experimental class and the control class is not different from the descriptive statistics. The average increase in reflective thinking skills of the experimental class and the control class can be seen in the following figure 5:

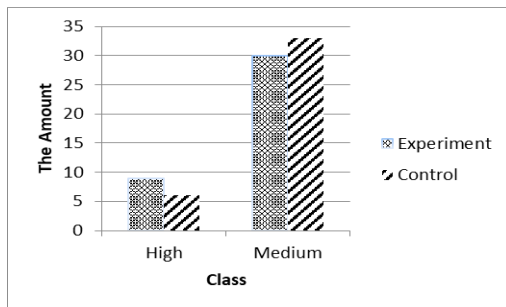


Fig. 5. Average chart increased reflective thinking skills.

Based on the figure 5 above, we can see that the increase in the experimental class reflective thinking skills is higher than the control class. So, based on descriptive statistical analysis, there is a higher increase in the experimental class's reflective thinking skill compared to the control class.

Furthermore, inferential analysis is carried out to get the conclusion of whether the increase in reflective thinking skills of experimental class students is better than the control class. The gain data analysis in this study consisted of prerequisite tests and continued with two different test averages to obtain conclusions.

After the prerequisite test is carried out, the calculation is continued with a test of the difference of two average one party can be seen in the following table 6:

TABLE VI. MANN-WHITNEY DATA GAIN

Types of Test	Statistic	Decision
Test-t	$t_{count} = 2.34$	There is an increase in ability
	$t_{table} = 1.99$	

Based on the above table it produces a value of $2.34 > 1.99$ which means that $t_{count} > t_{table}$ is that H_0 is rejected. This means that the improvement of the reflective thinking skills of the experimental class students is better than the control class students.

5) *Categorization of reflective thinking skills increase:* The results of the Gain acquisition of the reflective thinking skills of the experimental and control classes were categorized into three categories, namely high, medium and low category students. The description of the results of the Gain student acquisition category as follows figure 6:

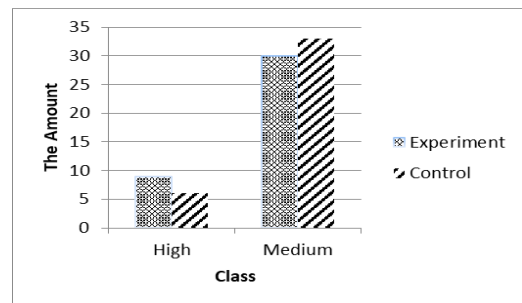


Fig. 6. Categorizing data gain reflective thinking skills.

From the figure 6 above, it can be seen that the percentage increase in the experimental class is more included in the high category while the control class is more in the medium category. This is by the results of the analysis that the increase in the experimental class reflective thinking skills is better than the control class.

6) *Analysis of students reflective thinking skills based on indicators:* To see how the quality of each indicator of reflective thinking skills in the experimental class and control class is by calculating the percentage obtained in each indicator. The quality of each indicator is presented in the following table 7.

TABLE VII. CATEGORY PERCENT OF EACH INDICATOR REFLECTIVE THINKING SKILLS

No	Indicator	Class	Percentage	Category
1	Evaluate / verify the truth of an argument based on the concepts / properties used	Experiments	67.31%	Sufficient
		Control	89.10%	Good
2	Distinguish between relevant and irrelevant data	Experiments	67.31%	Sufficient
		Control	60.26%	Sufficient
3	Can interpret a case based on a mathematical concept	Experiment	75.00%	Sufficient
		Control	55.45%	Sufficient
4	Analyzes from two similar cases	Experiments	82.05%	Good
		Control	74.04%	Sufficient
5	Generalize and analyze generalizations	Experiments	83.97%	Good
		Control	82.05%	Good

Percentage description of each ability indicator in the experimental and control classes in the following figure 7:

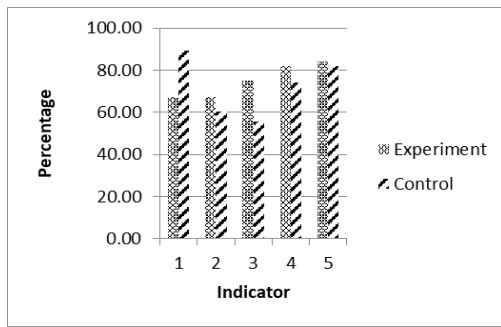


Fig. 7. Percentage of Each Indicator Reflective Thinking Skills

B. Discussion

1) *Reflective thinking skills of students'*: The results of the analysis showed that the final achievement and improvement of the experimental class's reflective thinking skills were better than the control class. This means that learning using the Realistic Mathematics Education (RME) approach can improve students' reflective thinking skills. Another factor that supports that the RME approach can improve the ability of reflective thinking is the principle of RME which is Progressive mathematization or progressive mathematics [8]. This principle emphasizes mathematization can be interpreted as an effort to direct mathematical thinking. It is said to be progressive because there are two mathematical steps, namely horizontal and vertical mathematical originating from a given contextual problem and ending informal mathematics. The students were first trained to be accustomed to forming mathematical thinking with realistic problems, after which students were guided by vertical mathematics to lead to formal thinking related to mathematical concepts.

Another factor that supports the RME approach to improving reflective thinking skills is the principle of self-developed models [8]. In this principle it is very possible for students to form bridges in the form of models. This model will guide students in formal mathematical thinking. At the initial

stage, the model that students make is usually still simple and similar to the contextual problem (model of). In the next stage students can make a model that leads to formal mathematical thinking (model for). The formation of this model helps students to understand abstract mathematical concepts so that students' reflective thinking skills are better, which focuses on teacher choices in teaching strategies, learning content/material, and goals, develop reflective learning models [9].

This explains why the final achievement and improvement of the reflective thinking skills of students who get learning with the RME approach is better than students who get learning using conventional approaches.

2) *Students' mistakes in working on reflective thinking skills tests*: Next we will discuss the ability to think reflective based on indicators. This discussion aims to determine the achievement of students' reflective thinking skills and what mistakes are made by students in carrying out tests of reflective thinking skills. According to Lerner common mistakes made by students in doing mathematical assignments are lack of knowledge about symbols, lack of understanding of place values, use of erroneous processes, miscalculations, and unreadable writing so students make mistakes because they are not able to read his own writing again. In line with Lerner explains the students' mistakes in working on mathematical problems, among others:

- Errors in making mathematical modeling.
- Misconception, which is an error in understanding the concept.
- Systematic error, i.e. an error relating to the incorrect selection of the extrapolation technique.
- Strategy errors, namely errors that occur because students choose how to do things that are not right.
- Sign errors, i.e. errors in giving or writing signs or mathematical notations
- Calculating errors, namely errors in performing mathematical operations.

The following is an explanation of the ability of reflective thinking based on indicators.

a) *Evaluating / verifying an argument based on the concept / nature used*: For indicators evaluating / verifying the truth of an argument based on the concepts / properties used in the experimental class obtained 67.31% with good categories, while the control class gained 89.10% in the good category. With this achievement, it can be seen that students using the expository approach are better than students who get learning by learning Realistic Mathematics Education on indicators evaluating / verifying the truth of an argument based on the concepts / properties used. The difference between the two is 21.79%.

The material discussed in this study is to build a flat side space. So what is meant by evaluating / checking the truth of an argument based on the concept / nature used is that students can evaluate or examine a problem if there is data that is changed to work on the problem. This ability is seen from the ability and accuracy of students in evaluating / verifying the truth of an argument based on the concept / nature used. It can be said, the experimental class students were able to solve problems regarding the correctness of a surface area and the volume of the flat side space. jug control that has been able to solve the indicator problem evaluates / verifies the truth of an argument based on the concept / nature used. A common mistake in solving the question of reflective thinking ability test related to this indicator is that students do not understand the concept of the volume of a flat side space. Based on Sritarti's explanation above, the mistakes made by students belong to conceptual errors.

b) Differentiating between relevant and irrelevant data: For indicators differentiating between relevant and irrelevant data in the experimental class obtaining 67.31% with good categories, while the control class obtaining 60.26% with good categories. With this achievement it can be seen that students using the approach *Realistic Mathematics Education* are better than students who get learning with expository learning on indicators differentiating between relevant and irrelevant data. The difference between the two is 7.05%.

The purpose of distinguishing between relevant and irrelevant data is that students can distinguish which data is relevant and which is not relevant both at the completion of the surface area and the volume of the flat side space. This ability is seen from the ability and accuracy of students in distinguishing what elements are known in the case of the surface area and volume of the flat side space. It can be said, the students of the experimental class and the control class were able to solve the problem distinguishing between relevant and not relevant data even though some of them still had errors. A common mistake in resolving the reflective thinking ability test on this indicator is the lack of student understanding of what elements must be included to solve the problem of surface area and the volume of building a flat side space Based on Sritarti's explanation above, the mistakes made by students are included in systematic error.

c) Can interpret a case based on mathematical concepts: For indicators can interpret a case based on mathematical concepts in the experimental class to get 75.00% in good category, while the control class gets 55.45% in good category. it can be seen that students using the approach *Realistic Mathematics Education* are better than students who get learning with expository learning on analogous indicators of two similar cases. The difference between the two is 19.55%.

The purpose of being able to interpret a case based on mathematical concepts is that students can find the concept of building a flat side space that is associated in everyday life. Then students can distinguish which concepts can solve the problem of building a flat side space. This ability is seen from

the ability and accuracy of students in making formulas related to solving problems to build a flat side space that is students can solve the problem of the beam surface area that is associated in everyday life. It can be said, the experimental class students were able to interpret a case based on mathematical concepts well. As for the control class, it is not yet fully said that it is able to interpret a case based on mathematical concepts well. A common mistake in completing the reflective thinking ability test on this indicator is that students use the concept of overall beam surface area without seeing the problems that must be solved in the case, students enter the known data in the problem while to solve the problem correctly students should only uses the concept of the surface area of the beam using the broad formula in the absence of 2 pl. Based on Sritarti's explanation above, the mistakes made by students included systematic errors because students could not choose which concepts should be used so they could not interpret a case based on mathematical concepts.

*d) Thecasesanalogous:*Analogy of two similar for the indicators of two similar cases in the experimental class it gained 82.05% with a good category, while the control class gained 74.04% with a good category as well. With this achievement, it can be seen that students using the approach *Realistic Mathematics Education* are better than students who get learning with expository learning on analogous indicators of two similar cases. The difference between the two is 8.01%.

The purpose of analyzing two similar cases is that students can analogize or imagine a problem contained in a larger problem. This ability is seen from the ability and accuracy of students in analogizing small size cubes contained in large-sized cubes. It can be said, the experimental class students were able to solve analogous problems from two similar cases well. Likewise, with the control class, students in the control class were able to solve problems in analyzing two similar cases even though more answers were wrong compared to the experimental class. A common mistake in solving reflective thinking ability test questions related to this indicator is that they have not understood the concept that was asked in the question, there are students who only solve certain cases (only partially), there are students who solve a problem only the first concept right. Based on Sritarti's explanation above, the mistakes made by students are included in the misunderstanding of the concept.

e) Generalizing and analyzing generalizations generalizing: For indicators and analyzing generalizations in the experimental class, 83.97% were obtained in the good category, while the control class obtained 82.05% in the good category. With this achievement, it can be seen that students using the approach *Realistic Mathematics Education* are better than students who get learning with expository learning on indicators generalizing and analyzing generalizations. The difference between the two is 1.92%.

The purpose of generalizing and analyzing generalizations is that students can represent a problem into a different problem. In this problem, students must analyze and look for the concept of a flat-side volume building through another

volume concept. This ability is seen from the ability and accuracy of students in generalizing and analyzing generalizations. It can be said, the experimental class students were able to solve the problem of generalizing and analyzing generalizations as well as the control class. But the control class has more wrong answers to solve the problem. A common mistake in solving reflective thinking ability test questions related to this indicator is that students know the relationship between the volume of the pyramid and the volume of the cube, students do not build the pyramid space in the cube, students do not correctly describe the volume of pyramid originating from the volume of the cube. Based on Sritarti's explanation above, the mistakes made by students belong to conceptual errors.

IV. CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that:

- The achievement and improvement of reflective thinking skills of students who get learning with the approach realistic mathematics education is better than students who get conventional learning. The average score of students who get learning using the RME approach is 29.82 with an average gain of 0.65, while the average score of students who get conventional learning is 27.95 with an average gain of 0.58.
- Errors made by students in carrying out tests of reflective thinking skills include conceptual errors,

errors in making mathematical modeling, systematic errors and calculating errors.

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