Analysis of High Order Thinking Skill of Students in Contextual Problems Solving

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Abstract. This study aims to analyze the high-order thinking skills of students in solving contextual problems in calculus lectures. Currently, students are required to be more creative in solving calculus problems that lead to High Order Thinking Skill (HOTS) thinking, where students apply the knowledge and skills that have been developed during lectures in a new context. This type of research is qualitative, with a descriptive presentation method and a case study approach. The subjects in this study were six students of the January-June 2020/2021 semester mathematics education study program who were selected based on their level of ability to solve contextual questions. The data collection techniques used in this study were observation and written tests presented in contextual problems. Based on the research results, it can be concluded that student HOTS is determined by the student's ability to solve contextual questions, the higher the student's ability to solve contextual questions, the more HOTS indicators are achieved. HOTS students with high abilities are able to meet indicators of analyzing, evaluating, and creating. HOTS students with moderate ability are able to meet the indicators of analyzing and evaluating. HOTS students with low ability are able to only meet the analyzing indicators. The results showed that there were differences in HOT problem solving among students with high, medium, and low abilities.

1. Introduction

Global development in various fields of life demands increasingly fierce competition. Therefore, every individual who inhabits this world needs to have certain competencies in order to be able to compete in this era of globalization. Therefore, each individual must be able to think at a higher order of thinking skills/HOTS especially in the Calculus course. However, the problems that occur are that there are still many students who have difficulty solving problems in the form of HOTS so that they are not able to compete globally. To solve this problem, the researcher conducted a higher order thinking analysis in the calculus course, because calculus is one of the subjects that becomes a problem for students. Even though this course contains basic materials as prerequisites for other courses. For students of the mathematics education study program, as prospective teachers, apart from being the basic material, this course is also used as teaching material for high school students later.
Apart from being a compulsory subject for mathematics education study programs, this subject is also compulsory for mathematics study program students.

Based on the results of the researchers' documentation, the scores of the students' midterm and final semester exams in the calculus course in the mathematics study program also showed that their learning outcomes were still low, which only reached less than 50%. Increased thinking skills, especially those that lead to higher order thinking, need serious attention because of a number of studies [1]; [2] shows that mathematics learning in general still focuses on developing procedural low-stage thinking skills. One of the problems faced in the world of education is the problem of weakness in the learning process, because students are less motivated to develop their thinking skills. In class activities directed at students' ability to memorize information. Students do have a lot of knowledge, but they do not seek knowledge itself, they only wait for information presented by the lecturer and even the will. interventions are quickly forgotten. According to research conducted by [3]; [4], which explains that learning with rote and procedural skills, if not practiced, then the knowledge learned will easily be overlooked compared to the knowledge gained through deep understanding.

Earlier research also proved that students showed high-level thinking performance when learning was related to challenging questions,[5] suggested that one indicator of learning activities to run effectively and efficiently was the availability of many tasks that challenged students to use their brains to think. hard. Dialogue and discussion are important opportunities for learning [6]; [7]. Many attempts have been made to develop higher order thinking skills among students. Higher order thinking skills, known in common language as Higher Order Thinking Skills, are triggered by four conditions [8].

a. A particular learning situation that requires specific learning strategies and cannot be used in other learning situations.

b. Intelligence is no longer seen as an immutable ability, but rather a unity of knowledge that is influenced by various factors consisting of the learning environment, strategies and awareness in learning.

c. Understanding views that have shifted from unidimensional, linear, hierarchical or spiral towards understanding views to multidimensional and interactive.

d. More specific higher-order thinking skills such as reasoning, analytical skills, problem solving, and critical and creative thinking skills.

According to [9] that thinking is categorized consisting of basic thinking, critical thinking and creative thinking. These categorizations are not discrete and difficult to define precisely. However, Krulik and Rudnick provide descriptions is a complex thought process in describing material, making conclusions, constructing representations, analyzing, and building relationships involving the most basic mental activities. These skills are also used to underline various high-order processes according to Bloom's taxonomic ladder. According to Bloom, skills are divided into two parts. First are low-level skills that are important in the learning process, namely remembering, understanding, and applying, and the second are those classified into higher-order thinking skills in the form of analyzing, evaluating, and creating.

The implementation of activities in the problem-solving process should be developed for situations that are more natural in nature and for approaches that tend to be informal. For the theme, the problem is taken from everyday events that are closer to student life or which are thought to attract students' attention. Real life everyday requires mathematics and daily problems are not routine things that require creativity in solving them [10]. Contextual problems are problems that are appropriate to the situation experienced by students, in accordance with real life and close to students.

One of the aspects of contextual learning is contextual math problems. According to [11], mathematics contextual problems are mathematical problems that use various contexts so as to present situations that have been experienced in real terms for students. In this problem, the context must be in accordance with the mathematical concept being studied. Context itself is defined as a situation or phenomenon/natural occurrence related to the mathematical concept being studied. De Lange [11]
states that there are 4 kinds of contexts, namely student personal, school/academic, community/public, and scientific/mathematical. Student personal context means situations related to the daily life of students both at home with family, with playmates, classmates and their fun. School/academic context means situations related to academic life at school, in classrooms, and activities related to the learning process. The community/public context means a situation related to the life and activities of the community around where the student lives. The scientific/mathematical context means a situation related to scientific phenomena and substance or related to mathematics itself.

Contextual problems are problems that are known to students and are relevant to everyday life. Meanwhile, contextual mathematics problems are mathematical problems that use various contexts so as to present real situations that have been experienced by students. In this study, the contextual problems given to students are problems related to the use of integrals, because in everyday life there are often problems using these materials. Therefore, the author wants to know the ability of students to solve contextual problems related to the material including HOTS assessments on indicators of analysis, evaluation, creating. Here's an example of a contextual problem about using integrals

1.1. Contextual Problems 1

Dolphins playing ball on Ancol beach. If he swims carrying the ball from the point -2 and arrives at the point 0, bounce the ball upwards until the ball falls on the point 2. The trajectory of the bouncing ball turns out to be a curve like the picture on the side. Help the dolphins calculate the area of the plane formed by splashing water from the ball, as seen in the image on the right.

Figure 1. Contextual Problems 1

1.2. Contextual Problem 2

Mother has a vase of the same shape as a trumpet for home decoration because it is very compatible with the type of flower that has a tall stalk. This type of trumpet-shaped flower vase makes your home's interior look good and of course elegant. So that the flowers in the trumpet vase stay alive and fresh, Mother changes the water in the flower pot above, mother want to know if the water in the vase is 3.7 πml, how many ml of water do you need to match the size of your vase, which is presented in the graph above, is rotated around the y-axis.

Figure 2. Contextual Problems 2
1.3. Contextual Problems

Budi’s father is repairing one of the chandeliers in his house. Budi also paid attention to the 4 inch high lamp holder. It turns out that in the lamp holder, there is an empty space on the edge. Budi tries to calculate the volume of the free space. After measuring, and drawing it well on paper, we get the curve of the lamp parabolicy = and draws a line on the edges to form y = −x² + 4 and y = −2x+ 4. Help Budi to find the volume of the free space where the lamp is! rotated through the y-axis.

Figure 3. Contextual Problems 3

2. Methods

This type of research is descriptive qualitative with a case study approach. Qualitative research is research that produces descriptive data in the form of spoken or written words from the person or subject being observed [12]. Students' ability in solving contextual questions was traced through giving contextual question tests. The research sample of mathematics education study program students taking Calculus in the January-June 2020/2021 semester was taken by purposive sampling at each level of high, medium, and low categories. Data collected by observation is a technique that is carried out by making careful observations and recording systematically [13] and giving tests. Data Analysis Phase, the researcher analyzed the data from the observations and tests that had been carried out then classify the data obtained based on the HOTS ability indicator. The research subjects were 6 students, of which 2 from the high group 2 from the medium group and 2 from the low group. Data analysis in this study uses data presentation is one of the qualitative data analysis techniques. Then used the presentation of activity data and a collection of information that has been compiled so that it is possible to draw a conclusion.

3. Results and Discussion

This research was carried out on students taking calculus courses in the mathematics department in the January-June semester of the 2020/2021 school year. This research activity was carried out for three meetings with a reference of 2x50 minutes for each meeting. The results of the research that has been carried out during three meetings in calculus lectures show the results of the mathematics contextual problem test that have been given to students which have been done individually and analyzed using a scoring rubric that has been developed by researchers based on the HOTS assessment rubric. Furthermore, from the contextual questions test results obtained from the low ability group to the high ability group. The results of this study are classified based on the abilities of students who are categorized as low, medium, high. The following is a description of the results of the contextual question work of each group. The results showed; The details of the scores of the selected subjects are as follows:

| No. | Interval                  | Information |
|-----|---------------------------|-------------|
| 1   | N < Mean - SD             | Low         |
| 2   | Mean - SD ≤ Mean + SD    | Moderate    |
| 3   | N > Mean + SD            | High        |
Table 2. Value of Research Subjects

| No. | Subject | Score | Information |
|-----|---------|-------|-------------|
| 1   | H1      | 88    | High        |
| 2   | H2      | 84    | High        |
| 3   | M1      | 79    | Moderate    |
| 4   | M2      | 73    | Moderate    |
| 5   | L1      | 35    | Low         |
| 6   | L2      | 19    | Low         |

3.1. Low Level Ability

In solving question number 1, students with low ability (L1) have not met the "analyze" indicator, where students cannot formulate the use of the area of the equation correctly. In Figure 1, Respondent L1 is unable to analyze and determine each integral boundary correctly. So that L1 has not been able to choose the appropriate solution method. Meanwhile, L2 students chose to determine each integral boundary correctly, but could not evaluate it so they could not write down the results of the answers obtained. At the time of solving these questions, respondent L1 and L2 could not solve contextual problems. They also do not check the steps of the process again whether the steps are correct.

Low ability students, students are less able to understand the problems given in the form of essay questions, students cannot write down what is the main problem presented. So that students cannot write down exactly what is the subject of the problem. The inability of these students is due to students' lack of understanding of the integral limits and completion techniques. To overcome this, the teacher should pay special attention to students with low abilities by providing additional hours outside of hours of learning activities in class personally or with study groups for students whose grades still below average.
3.2. Medium Level Ability

In solving problem number 1, students with moderate ability meet the "analyze" indicator, the students can determine the integral limit correctly. In Figure 5, the M1 subject is able to correctly analyze and solve each integral boundary. The indicator "evaluates" while the respondent M2 can choose the appropriate method of completion. In Figure 5 students are able to choose the appropriate solution way, students choose to solve existing problems using the integral technique. Indicators "create" in students cannot conclude the answer according to the question. In Figure 5, the M1 respondent cannot conclude from the results of the answers according to the questions by writing the results of the answers obtained. M1 and M2 respondents were able to mention the main points of something that was being done or faced. It was proven that they were able to state what information was known and asked in the questions. But they haven't finished their work yet, because they can't evaluate it.

For the results of students with moderate ability to show results in each of the following aspects on the aspect of understanding contextual questions and even being able to carry out the completion plan shows results that are categorized as good, but students have not been able to provide an evaluation of the answers being asked.

Figure 5. Scan of Answers Number 1 for Respondents M1
3.3. High Level of Ability

In solving question number 1, high ability students meet the "analyze" indicator, because students can determine each integral boundary correctly. In Figure 6 students are able to correctly analyze and determine integration techniques. The indicator of "evaluating" is understood by students who can choose the appropriate method of completion. In Figure 6, students are able to choose the appropriate solution way, students choose to solve existing problems using the method of integrating by paying attention to the integral boundary. The "creating" indicator is fulfilled by students because they can conclude the answer according to the question. In Figure 6 students can conclude from the results of the answers according to the questions by writing down the results of the answers obtained.

Respondents H1 and H2 were able to mention the main points of something that was being done or faced. It was proven that they were able to state what information was known and asked in the questions. They also provide reasons that support the conclusions drawn appropriately, which are then used during the conclusion process. Respondent H1 and H2 are able to reveal important factors that need to be considered in making conclusions / decisions. Students with high abilities show the results of each aspect, namely being able to write down what is the subject matter which is presented in the form of questions correctly. To carry out the completion plan shows results that are categorized as good, this can be seen from the ability of students to solve the questions given correctly. Students can understand the integral technique well individually. This shows that students are able to understand the material well. The individual learning objectives can be achieved in accordance with the objectives. However, students have not been able to provide different alternative answers.

4. Conclusion

Based on the results of research on the analysis of students' high order thinking skills in solving contextual problems for students, it can be concluded that: 1) HOTS students with high abilities are able to meet indicators of analyzing, evaluating, and creating; 2) HOTS students with moderate ability are able to meet the indicators of analyzing and evaluating; and 3) HOTS students with low ability are only able to meet the indicators of analyzing, and cannot be said to meet the indicators of evaluating and creating.

Figure 6. Scan of Answers Number 1 Respondent H1
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