

Student's Critical Thinking Ability to Solve Problems HOTS in Regular, Acceleration, and Olympics Class Programs

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Abstract. *Critical thinking skills are one of the main objectives of learning Mathematics. HOTS questions are needed so that students are familiar with international standard questions. This study aims to describe the mathematical critical thinking skills of students in the Regular, Accelerated, and Olympic class. Qualitative descriptive research approach with case study design. The subjects of this study were three students who came from different class programs. The research instruments used were tests and interviews. Data analysis used the following procedures: reduction data, data presentation, and conclusion drawing. The results showed that the Regular class students had 'low' critical thinking skills. Regular students are still confused about understanding the main idea of the problem, so the strategies used are not appropriate. Acceleration class students have 'good' critical thinking skills. Accelerated students can answer questions briefly and concisely, less thorough in drawing final conclusions. Olympiad class students have 'very good' critical thinking skills. Student answers are complete and clear. Olympiad class students understand the main purpose and objectives of the questions so that they lead to correct procedures and calculations.*

Keywords: *critical thinking ability, HOTS problems, regular, acceleration, olympics*

Introduction

Mathematical critical thinking ability is referred to as a specific ability to improve the quality of Mathematics learning, and is seen critical to succeed in Mathematics instructions (Erdogan, 2020). Critical thinking is defined as a problem-solving process in the assessment of certain cases, which is aimed to develop knowledge (Tiruneh, Verburch, & Elen, 2014). The ability is one of crucial abilities in Mathematics education including some skills, i.e., problem-solving, logical thinking, questioning, and analysis (Tiruneh et al., 2014). In addition, it signifies a series of processes that include understanding, analyzing, synthesizing, evaluating, interpreting, and reviewing (Arviana, Irwan, & Dewi, 2018). Furthermore, critical thinking is about to develop rational criteria in an attempt to observe, analyze, and evaluate values in specific ideas, phenomena, and facts to be converted into personal thoughts (Erdogan, 2020). In its real-life practices, critical thinking skill ability in Mathematics involves analyzing arguments, such as formulating word problems into mathematical models besides evaluating and reasoning over the offered solutions (Harti & Agoestanto, 2019).

In respect of Mathematics learning in schools, critical thinking ability needs to be unified and emphasized in the curriculum so that students can learn and implement the skills within to enhance their performance and reasoning ability (Chukwuyenum, 2013). In other words, it is so

central for students in all levels of education (Howard, Tang, & Jill Austin, 2015). Through critical thinking, students can make use of varied resources to explain issues and predict the outcomes (Duran & Dökme, 2016). Critical thinking also allows people to think rationally about certain cases that occur in the real life (Aizikovitsh-Udi & Amit, 2011; Švecová et al., 2014). Mathematical critical thinking ability provides students with clarity to identify problems and their possible connections, evaluate them, and make good and error-free conclusions over them (Tsui, 2017).

According to PISA in 2015, it was shown that Indonesia was ranked away from the ideal level in terms of student's critical thinking ability (Feriyanto & Putri, 2020). The lack of critical thinking ability may reflect that someone is of low capacity (Arviana et al., 2018). That students cannot acquire adequate understanding on specific topics in certain subjects is deemed as the most influential reason why their critical thinking ability is low (Sapta, Pakpahan, & Sirait, 2019). Besides, providing students with problems whose answers are only limited to memorization, instead of HOTS, makes them less trained and accustomed to deal with problems that require HOTS to answer (Budiman & Jailani, 2014).

Creative and critical thinking skills are part of HOTS (Heong, Othman, Yunos, & Kiong, 2011). It allows students to be more independent, skillful, and creative in problem-solving as they can make use of scientific contents based on the daily life context (Hugerat & Kortam, 2014). HOTS includes some critical skills, such as creative and critical thinking, analysis, problem-solving, and visualization (Ramos, Dolipas, & Villamor, 2013). In general, human's critical ability can be classified into two, LOTS and HOTS (Abdullah et al., 2017). The former involves three major elements of Bloom Taxonomy, i.e., memorizing (C1), understanding (C2), and applying (C3), while the latter is concerned on the other three next levels, i.e., analyzing (C4), evaluating (C5), and creating (C6) (Saido et al., 2015; Mardiana & Kuswanto, 2017).

Furthermore, interpreting data and making conclusions and reasoning over them are the challenges students have to undertake in problem-solving, which basically requires them to use HOTS (Susanti, Kusumah, Sabandar, & Darhim, 2014). In Junior High School level, the materials are related to geometric concepts in varied shapes, like cubes, beams, prisms, and pyramids. However, there are still a lot of students not fully understanding about the concepts, especially related to space concept. Specifically, flat-side space is seen as one of topics in Mathematics that can be used to measure student's higher critical thinking ability related to daily life context (Riadi & Retnawati, 2014).

The current research is focused on three students from three different class programs, i.e., Regular, Olympics, and Acceleration. According to Yuniarti & Budiani (2016), Regular class is principally administered based on curriculum standard of SBI (International-Based School).

Meanwhile, Olympics class is a purposeful program designed to infuse extra materials special for Olympics sessions (Olympics-focused learning), but the core of its instructional activities is still parallel with SBI curriculum standard. It is basically intended to prepare students for academic competitions (Utomo, 2018). In addition, Acceleration class program is conducted as a strategic educational endeavor that helps students undertake fast-paced education through a special curriculum, allowing them to finish education faster than it regularly is supposed to be (Rahma, 2017). The class is exclusively designed for distinguished students with excellent ability or intelligence, in faster and further leap of material delivery than that of in Regular class (Moreno, 2010). In the first academic year, Acceleration class students will learn about entire materials for Grade VII (Junior High) or Grade X (Senior High) and half of materials for Grade VIII (Junior High) or Grade XI (Senior High), and will undertake the remaining materials when they have reached the second academic year after all (Rahma, 2017).

The current research is parallel with one by (Saparwadi & Anita, 2018), which analyzed student's problem-solving ability for mathematical problems in Regular and Acceleration class programs. The research indicated that problem-solving ability performed by Acceleration class students was relatively higher than those of in Regular one. Moreover, research carried out by (Rosmayadi, 2017), analyzing student's mathematical critical thinking using 7E learning cycle model, showed that the learning model was effective to enhance mathematical critical thinking. Therefore, in terms of novelty, the current research is focused on the inclusion of flat-side space integrated with HOTS problems to analyze student's mathematical critical thinking ability in three different class programs, i.e., Regular, Olympics, and Acceleration – which will be the sole differentiator of the current research from the previous. Further, the research is considered critical due to the fact that critical thinking skill falls into one of main goals of Math instructions through problems with HOTS. In addition, the problems with HOTS are also necessary to make students get more accustomed to international-levelled questions or tests.

In regard to the abovementioned exploration, issues related to student's critical thinking skill in solving problems with HOTS seem interesting to the researchers, which leads to basic intention to continue studying the student's mathematical critical thinking skill more deeply, especially amidst a group of students from regular, acceleration, and Olympics class programs through a series of problems that need HOTS. It is expected that research can be a reference for teachers in providing students with proper guidance for the students from those class programs in the reinforcement of student's mathematical critical thinking skill in solving problems with HOTS. This research is aimed to describe student's mathematical critical thinking ability to solve flat-side space problems in Regular, Acceleration, and Olympics class programs.

Method

The current research employed a descriptively qualitative approach. Basically, qualitative research constitutes a kind of social behaviors highlighting how people interpret and understand their own experiences in order to see a state of one's social reality. The research was conducted on a semester of Academic Year 2020/2021. Furthermore, the research subjects were three students from one of the junior high schools in the city of Malang. Each of the students was from different class program: one from Regular class, one from Acceleration, and the other one from Olympics. In addition, the selection was based on the recommendation form the teacher. For the subject of the regular class taken from students who follow the standard curriculum in schools in general. Meanwhile, the subject of the Olympic class is taken from students who often participate in quiz competitions, and often participate in training on Olympic questions. For acceleration class subjects are taken from students who have excellent abilities and intelligence, and are prepared for class acceleration if they meet the qualifications.

To collect data, test and interview were conducted. The test was essay concerning flat-side space based on HOTS, encompassing two numbers set based on key indicators of critical thinking ability, i.e., interpretation, analysis, evaluation, and interference. In addition, the test had been, in advance, verified by validators. Meanwhile, the interview was aimed to validate the data, which had been designated based on the interview guidelines. Further, for data analysis interests, some procedures were carried out, involving data reduction, data display, and conclusion making. At the end, data obtained from the test and interview sessions would be displayed descriptively so as to formulate good conclusions.

Moreover, data analysis technique carried out in this qualitative research included data reduction, data display, and conclusion (Miles, Huberman, & Saldana, 2014). In data reduction, data of the critical thinking test and interview results were reduced following the goal of the research. In addition, data display included exhibiting the data obtained from the critical thinking test and interview results in the form of description, which was used as the basis for conclusion. At last, in conclusion, the researchers used the indicators of mathematical critical thinking skill to formulate the final answers for the research problems.

Results and Discussion

Student's critical thinking ability in regular class

Figure 1 that follows depicts an answer made by a student of Regular class, as symbolized by (SR):

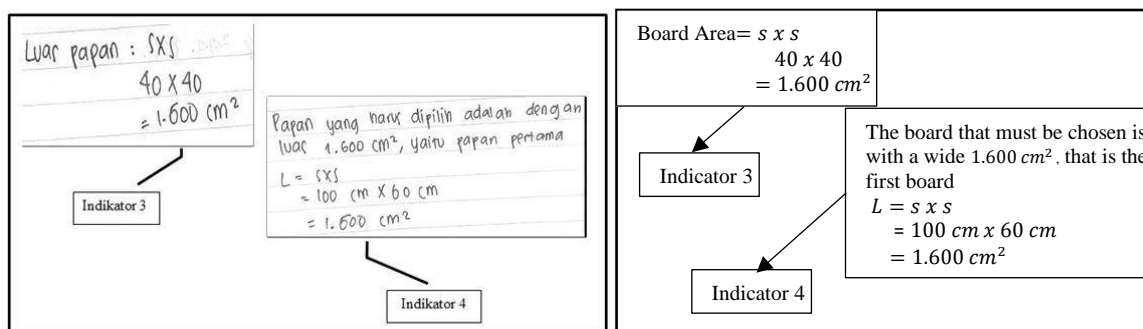


Figure 1. The answer made by the student from regular class

Based on Figure 1, it is shown that SR only met two out of four indicators of mathematical critical thinking ability, i.e., Indicator 3 (referred to as 'evaluation') and Indicator 4 ('conclusion'). In terms of evaluation, SR could answer the problem, but with mistaken calculation – the area of a space (a cupboard) was calculated based only on one single side. It indicated that SR could not evaluate the data and implement a certain strategy in the calculation, still. Moreover, in terms of conclusion, SR formulated a wrong answer and inappropriate reasoning for board selection case. Inappropriate calculation for evaluation caused a mistaken conclusion, which demonstrated that SR could actually not answer, make a conclusion, and make a good and right decision over the problem given. The following is the excerpt of interview with SR:

- T : What is the main problem of the question?
- SR : Choosing a board Grace should go for.
- T : How will you solve the problem, then?
- SR : I need to seek for the board area using the cube area formula – side x side, Mam.
- T : What conclusion can you make from your answer?
- SR : Grace should go for the board whose area is 1.600 cm², Mam.

According to aforesaid interview excerpt, it is seen that SR was still lost in understanding the key idea of the question, resulting in inappropriate strategy used to answer it. SR, in fact, was only focused on one single side of the cupboard, and neglected the other sides. As a consequence, the student did a mistake in the calculation using the cube area formula. Some mistakes made by SR in answering the problem were due to low mathematical critical thinking ability, exclusively based on Indicator 1 ('interpretation') and Indicator 2 ('analysis'). Interpretation and analysis facets demonstrated that SR still could not understand and clarify the problem, which made them unable to examine, identify the actual meaning of, and design appropriate strategy to answer the problem. Further, the lack of understanding and good strategy planning could also be deemed as the causes of miscalculation and improper conclusion.

Student's critical thinking ability in acceleration class

Figure 2 that follows depicts an answer made by a student of Acceleration class, as denoted by (SA):

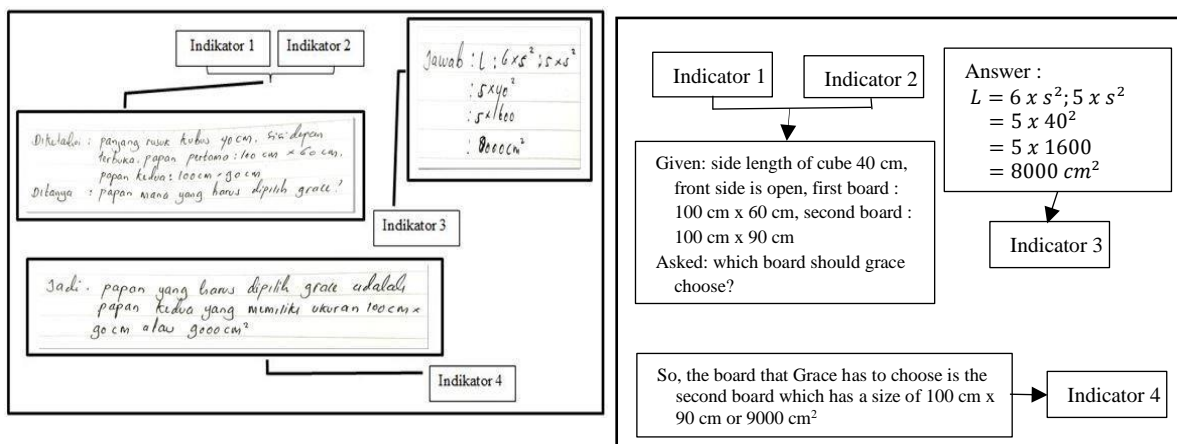


Figure 2. The answer made by the student from acceleration class

Based on Figure 2, it is shown that SA had met all of the indicators of mathematical critical thinking ability. In terms of interpretation, SA could get the meaning of the question and jot down what was identifiable from the question. Therefore, it can be concluded that SA had been able to apprehend the problem and clarify the meaning pronounced by the problem. In addition, in terms of analysis, SA could insert the descriptions about what was questioned and what the key purpose of the problem was. It indicates that SA could already examine and identify the essential purpose of the given problem so as to help formulate the strategy to answer.

Further, in terms of evaluation, SA did the calculation well and correctly – by calculating the areas of 5 cupboard sides – but was still incomplete since the student forgot to calculate the board area I and II. Therefore, it can be stated that SA had been good enough to evaluate data and implement a strategy for calculation. Moreover, in terms of conclusion, SA had succeeded in formulating a conclusion over the problem, that the second board should be chosen to build a cupboard. However, the student did not attach reasoning for the board selection. Thus, it is clear that SA could solve the problem, but was less effective in making a conclusion and a decision.

The following shows the excerpt of interview with SA:

- T : What is the main problem of the question?
- SA : It requires us to choose which boards are the most suitable for use if we'd like to build a small cupboard with the ceiling opened.
- T : How will you solve the problem?
- SA : I'm going to write down what is clearly stated in the question. Then, I will calculate the cube area only if 5 cupboard sides are needed, Mam.
- T : What conclusion can you make from your answer?
- SA : I can conclude that Grace must go for the second board whose area is 9,000 cm².

Based on the interview, it is obvious that SA could get the intended meaning and purpose of the question given so as to result in correct procedure of calculation. However, SA was less careful to make a conclusion (Indicator 4 referred to as 'conclusion') due to the absence of reasoning over the given problem.

Student's critical thinking ability in olympics class

Figure 3 that follows depicts an answer made by a student of olympics class, as symbolized by (SO):

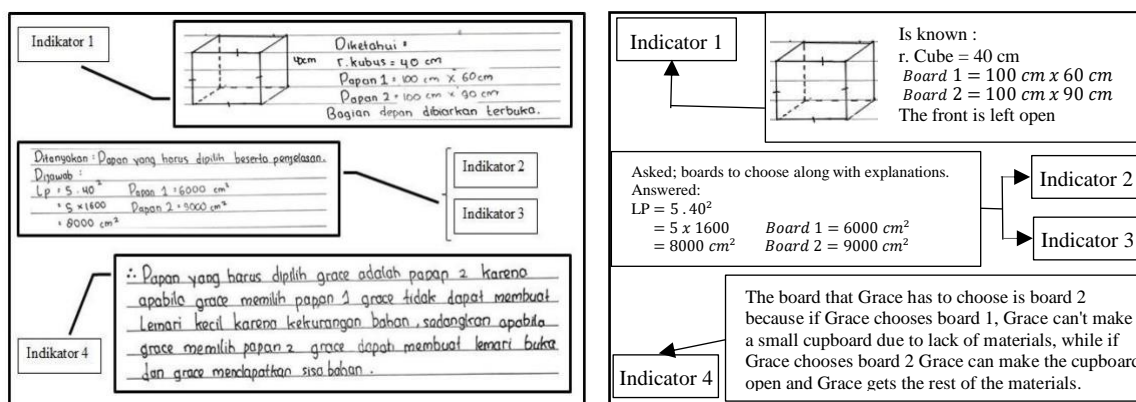


Figure 3. The answer made by the student from olympics class

According to Figure 3, it is portrayed that SO had met all of the indicators of mathematical critical thinking ability. In terms of interpretation, SO could already comprehend the meaning of the question and convert it comprehensively to a written form, exclusively about what was clearly stated from the question, complete with an illustrative portrayal. Therefore, it can be summed up that SO could understand the problem well and clarify the key meaning of the question. Regarding analysis, SO included a description of what was required to be sought for or the main purpose of the question either. By doing so, SO was deemed to have been able to examine and identify the purpose of the problem questioned, and to design an appropriate strategy to answer.

In terms of evaluation, SO did the calculation using a very excellent and good strategy to answer – by calculating the 5 cupboard sides areas, added with the board area I and II. Therefore, it can be concluded that SO was so excellent in evaluating data and applying a good strategy for calculation. Moreover, in terms of conclusion, SO had made a conclusion based on the answer of the question, which was that the second board was the most appropriate for the intended cupboard – complete with very good reasoning, because the board area I was smaller than the cupboard area, whilst the board area II exceeded the cupboard area so as to make it enough for use to build the cupboard, with leftovers remaining from the board II. In short, SO was highly able to solve the problem, and could make a good conclusion and a right decision. The following is the excerpt of interview with SO:

- T : *What is the main problem of the question?*
- SO : *It ask about which board must be selected if we want to build a small cupboard, with ceiling opened. Is it board I with 8,000 cm² area, or board II with 9,000 cm² area?*
- T : *How will you solve the problem?*
- SO : *I'm going to make some notes of what is clearly stated in the question and what needs to be sought for from the question. After all, I have to calculate the cube area*

when it needs to have its ceiling opened. At last, I make a conclusion based on the result of calculation I'm done with, Mam.

T : What conclusion can you make from your answer?

SO : I can conclude that Grace should choose the second board, Mam because if she goes for the first, she will have lack of materials. Conversely, she will still get leftovers if she goes for the second.

According to the interview, it is definite that SO really got the point and key intention of the question given so as to lead to correct procedure of calculation. SO, in other words, had met each of the indicators of critical thinking ability.

Mathematical critical thinking ability of students in Regular, Acceleration, and Olympics class programs, based on aforesaid data analysis, had shown different results in its application to answer flat-side space problems through HOTS. In regard to the indicators of mathematical critical thinking skill, it can be inferred that students from the Regular class program did not fully meet two of the indicators, *interpretation* and *analysis*. The foregoing was caused by their lack of understanding on the given problems, exclusively on the use of formula to calculate the area of the cupboard with an open-sided front. Regular students are still unable to understand and clarify problems, which makes them unable to examine, identify the true meaning, and design appropriate strategies to answer problems. Regular grade students are students with average mathematical abilities, using the regular grade curriculum.

In Olympics class program, students completely and comprehensively succeeded to meet each of mathematical critical thinking indicators. Olympics students are able to understand the questions and convert them comprehensively into written form then Olympics students do the calculations using a very good and good answer strategy. Furthermore, Olympics students are very good in data research and apply good calculation strategies. This is because the learning process in the Olympics class is prepared to take part in the competition, has a different curriculum from regular classes in general, they are guided by special experienced teachers accompanying the Olympics. The Olympics class is a program that aims to include additional material specifically for Olympic-focused learning, which aims to prepare students for academic competition (Utomo, 2018).

Further, students from the Acceleration class program had completely met each of critical thinking indicators, but with less solid understanding on the *inference* indicator. It is due to the fact that the students could make the conclusions, but without any detailed reasons. Accelerated students can understand the intent of the question and note what can be identified from the question. then accelerated students can perform calculations properly and correctly. Furthermore, accelerated students have succeeded in formulating conclusions on these problems, but are less effective in drawing conclusions. Moreover, in answering the problem, the student from Acceleration class undertook four phases, such as preparation, incubation, illumination, and

verification (Defitriani, 2014). The accelerated class students are selected from the best math and science achievement students, using a special accelerated curriculum, and experienced math teachers in accelerated classes. This finding is in line with Habiba et al., (2015), asserting that Acceleration program is intentionally aimed to facilitate students with excellent academic achievements, talents, and skillfulness. Acceleration class students possess excellent intelligence, and they are equipped with high pace and motivation in learning (Husna & Ardiani, 2014). In line with the above research results (Karim, Ibrahim, & Yusuf, 2018) there are differences in students' mathematical problem solving abilities between the accelerated class and the regular class, where the average value of the results of students' mathematical problem solving abilities for the accelerated class is higher than the average value of the results of the regular class students' mathematical problem solving abilities.

Conclusions

Based on the findings, the conclusions are formulated as follows. The student of Regular class was shown to have relatively 'low' mathematical critical thinking ability to solve flat-side space problems through HOTS. The lack of understanding and planning to design a good strategy to answer the question negatively affected the calculation and conclusion-making. Meanwhile, the student of Acceleration class could perform 'good' mathematical critical thinking ability in solving flat-side space problems through HOTS. The student, further, could answer the question, briefly and concisely. In addition, the 'good' state of mathematical critical thinking ability of the student from Acceleration class was echoed by the three first indicators, with undistinguishable reasoning over the formulated answer. On the other hands, the Olympics class student appeared to possess 'excellent' mathematical critical thinking ability in case of answering flat-side space questions through HOTS. The student could comprehensively and clearly answer the questions, complete with an illustrative portrayal of flat-side space, in this case a cube, consistent with the question.

All in all, further research is necessary to be conducted to improve student's mathematical critical thinking ability, especially in Regular class, with reference to the findings pronounced by the current research.

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