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THE IMPLEMENTATION OF SCIENTIFIC APPROACH WITH GROUP SETTING TO IMPROVE THE 11TH GRADE SCIENCE 6 STUDENTS' MATHEMATICAL CRITICAL THINKING SKILLS AT SMAN 22 BANDUNG IN THE LEARNING OF DERIVATIVES AND ITS APPLICATIONS

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3nurimanemong@gmail.com Received: XXXXX X, XXXX; Accepted: XXXXX X, XXXX

Abstract This study was conducted under the action research method.

It aims to analyse the role of scientific approach to Mathematical Critical Thinking (MCT) skills of high school students. This study was conducted in SMAN 22 Bandung and involved 31 students from grade XI Science 6 as participants and three essays of MCT test as the instruments. This study was conducted in three cycles. The researcher found that there was an improvement on the students' MCT skills from cycle to cycle.

The students encountered difficulties in solving problems related to identifying relevant and irrelevant data; hence, they did not encounter any difficulties in examining the validity of the process. Keywords: Mathematical Critical Thinking skills

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Matematis Siswa SMA Kelas XI MIPA 6 SMAN 22 Bandung Pada Materi Turunan Dan Penerapannya Melalui Pendekatan Saintifik dengan Setting Pada Kelompok. JIML, X (X),

XX-XX.

INTRODUCTION In the past few years, Indonesia education assessment system has been developing Higher Order Thinking Skills (HOTS)-based assessment system with regards to the amendments of 2013 curriculum in assessment standards, particularly in

Mathematics. It is designed to build students' Critical Thinking skills in solving proposed problems.

In addition, the learning process is expected to allow students developing their critical thinking skills as parts of requisite competences in the future (Prihartini, Lestari, & Saputri, 2015). Many experts have conducted researches related to Mathematical Critical Thinking (MCT) skills. The findings showed that students still encountered difficulties in answering critical thinking questions.

Sariningsih dkk found similar results to their research which showed that the participants encountered difficulties in solving mathematical problems related to identifying relevant and irrelevant data in a given case (Sariningsih, Sumarmo, Zulkarnaen, Hamidah, & Hidayat, 2015). In line with the findings, Mulyana dkk also discovered similar findings which related to students' ability in examining and proving the validity of counting process.

Therefore, this research aims to analyse the improvement of high school students' critical thinking skills - in the topic of derivative and its application, students' performance, and students' difficulties when completing MCT test. THEORETICAL REVIEW Mathematical Critical Thinking is the foundation of thinking skills which is used to analyse arguments and to generate ideas towards each meaning in order to develop logical mind set. Some experts define the term 'critical thinking' with different expressions, however, the core meaning remains the same.

Ennis (Sariningsih et. al., 2015) states that critical thinking is a reflective thinking which is full of considerations and decision makings about what is believed and what is done. Similar idea is proposed by Noer (Jumaisyaroh, Napitupulu, & Hasratuddin, 2016) who states that mathematical critical thinking is a process of thinking which leads to conclusion drawing about what we should believe and what future action we should take; whereas, Susanto (Jumaisyaroh et.al.,

2016) proposes that mathematical critical thinking is a thinking activity about ideas or notions which relates to concepts or given problems. Furthermore, Gokhale (Hendriana, Rohaeti, & Sumarmo, 2017) defines the term 'critical thinking' as a process of thinking which involves analysing, synthesising, and evaluating concepts. Critical thinking also involves manipulating data or information in order to make them more meaningful.

Referring to the abovementioned definitions of critical thinking by those experts, it can be concluded that mathematical critical thinking is basically an ability that requires students to verify the validity of concepts before accepting them. Therefore, based on

the indicators of mathematical critical thinking proposed by the experts, this research used the following indicators: 1) verifying the validity of a statement, 2) identifying relevant and irrelevant data, 3) identifying the validity of the process, and 4) composing answers along with reasons.

METHOD The method used in this research was classroom action research which refers to a reflective analysis compiled by the researcher in order to deepen the understanding throughout the learning process. The subject of this research was 31 grade XI Science students of SMA Negeri 22 Bandung in academic year 2018/2019. The instruments of this research were three essays of MCT test in each cycle and interview guidelines for some participants.

Sample item of mathematical critical thinking test Verifying the validity of a statement Verify the validity of the following statement: The first derivative of $f(x)$ is $f'(x)$. Illustrate the explanations. Identifying relevant and irrelevant data A polynomial $f(x) = x^3 + ax^2 + bx + c$ formulated with data value $f(-1)$, $f'(-1)$, and $f''(-1)$ sequently 8, -8, and 0.

f' is the first derivative of function f and f'' is the second derivative of function f . Are the data sufficient to determine formula $f(x)$? Are there any irrelevant data? If the data are not sufficient, complete the data and explain each of the process. **FINDINGS AND DISCUSSION** Findings This study was conducted in three cycles. Each cycle was done in one meeting of 3 hour-lesson.

In the first cycle, the learning process incorporated discussion method; however, the discussion was done in pairs (Figure 1). The MCT test result in Cycle I is shown in the following table: Table 1 Result of Mathematical Critical Thinking Test in Cycle I

Q	1	2	3	Total
Maximum Score	6	4	8	18
Average	4,97	3,03	1,87	9,88
%	82,80	75,81	23,39	55,91
Number of Ss who passed	27	20	4	5
Studying Mastery Percentage	87,10	64,52	12,90	16,13

Notes: Indicator Question 1 : identifying the validity of the process Indicator Question 2 : verifying the validity of a statement Indicator Question 3 : identifying relevant and irrelevant data From the above shown table, it can be seen that most of the students (87, 10% for Question 1 and 64, 52% for Question 2) were able to complete the questions. Nevertheless, there was only small number of students (12, 90%) who were able to complete the question.

Overall, there were 16, 13% of students who are able to pass or to obtain higher or equal score to the Minimum Mastery Criteria in Mathematics. From the observation, the researchers carried on reflections to improve the learning process. The learning process in Cycle 2 was then designed. Discussion method was still used, however students were to choose their own groups.

The shift was expected to improve students' participation in the learning process as well as students' MCT skills. Data from Cycle 2 are shown in the following table: Table 2 Result of Mathematical Critical Thinking Test in Cycle 2_Q 1_Q 2_Q 3_Total _Maximum Score _6_15_6_27 _Average _1.13_9.87_3.71_14.71 _%_14.11_65.81_61.83_54.48 _Number of Ss who passed_0_16_10_7 _Studying Mastery Percentage_0.00_51.61_32.26_22,58 _Notes: Indicator Question 1 : identifying relevant and irrelevant data Indicator Question 2 : solving mathematical problems along with explanations Indicator Question 3 : verifying the validity of a statement According to Table 2, none of the students were able to complete Question 1 correctly.

Most of them (51,61%) were able to complete Question 2 and a small number of students (32,26%) were able to complete Question 3 with 75% result score higher than the minimum score. The result of MCT test in Cycle 2 showed that there was an increase in the percentage of students who were able to exceed the Minimum Mastery Criteria, even though the increase was not significant. From the result of the observation and the test in Cycle 2, the researcher planned to make some amendments for the next cycle.

In order to make the students understand the lesson more, the researcher decided to arrange the learning process in the form of group discussion; however, the groups were formed by distributing the students who had reached the Minimum Mastery Criteria in each group equally. The students were expected to help the other students who had not yet reached the criteria.

The result of the MCT test in Cycle III showed that there was an improvement in the number of students who were able to reach the Minimum Mastery Criteria. Nonetheless, the result was not yet satisfactory as the number of the students who had passed was not yet significant. The result of MCT test in Cycle III is shown in the following table: Table 3 Result of Mathematical Critical Thinking Test in Cycle 3 Variables_Q 1_Q 2_Q 3_Total _Maximum Score_10_6_8_24 _Average_6.13_3.00_7.16_16.29 _%_61.29_50.00_89.52_56.17 _Number of Ss who passed_13_9_28_14 _Studying Mastery Percentage_41.94_29.03_90.32_45,16 _Notes: Indicator Question 1 : solving mathematical problems along with explanations Indicator Question 2 : solving mathematical problems along with explanations Indicator Question 3 : verifying the validity of a statement The above shown table suggests that more than half of the number of the students (41,94%) were able to answer Question 1 completely; small number of the students (29,03%) were able to answer Question 2 adequately; and most of the students (90,32%) were able to answer Question 3 correctly.

Figure 1 Figure 2 Learning Process in Cycle I Learning Process in Cycle II Figure 3

Learning Process in Cycle III Discussion According to MCT test given in Cycle I to Cycle III, there was some improvement in students' MCT skills; even though, there were only 14 out of 31 students who were able to obtain score more than the Minimum Mastery Criteria.

The results of MCT test from Cycle I to Cycle III are shown in the following table: Table 4 Result of Mathematical Critical Thinking Test from Cycle 1 to Cycle 3 Variables _Cycle 1 _Cycle 2 _Cycle 3 _Maximum Score _18 _27 _24 _Average _9.88 _14.71 _16.29 _% _55,91 _54.48 _56.17 _Number of Ss who passed _5 _7 _14 _Studying Mastery Percentage _16,13 _22,58 _45,16 _ In cycle 1, there were only small number of students who were able to answer the MCT test.

The reason was because the students were not used to completing higher order thinking tests. However, most of the students were able to identify the validity of process; some of them were able to verify the validity of the questions; and only small number of students were able to identify relevant and irrelevant data – some of them did not complete the questions.

The result of Cycle II showed that there was some improvement even though it was not significant. On the other hand, the test result in Cycle III showed that the students' mathematical critical thinking skills were generally improved. It is in line with the previous study conducted by Syukur (Abdullah, 2013) and (Prihartini et. al.,

2015) who found that high school students; critical thinking skills can be developed through Open Ended approach. Based on the students' answer of the MCT test in Cycle I and II, it can be seen that the students found identifying relevant and irrelevant data question difficult to answer. Most of them were not able to identify relevant and irrelevant data. It is in line with the results of the previous study conducted by (Sariningsih et.

al., 2015). The study found that the participants encountered difficulties in completing questions on identifying relevant and irrelevant data. Nonetheless, most of the students were able to complete questions about verifying the steps of completion process and solving mathematical problems along with the reasons. This finding, on the other hand, was the complete opposite of the previous research conducted by (Mulyana et. al.,

2018) which stated that the participants encountered difficulties in completing questions of verifying the counting process. Based on the observation throughout the learning process in each cycle, students' performance was shown increasing regardless a small number of students who were still reluctant to participate.

Students' participation increased during the group discussions since they were comfortable asking to their peers instead of to the teacher. Group setting also played an important role in improving students' critical thinking skills. It is in line with the study conducted by Filsaime (Haryani, 2012) which states that in order to improve students' critical thinking skills through discussion method, the teacher should create comfortable atmosphere for students to interact with one another.

In conclusion, the learning process from cycle to cycle influenced students' ability in developing their critical thinking as stated by de Bono (1990) and Syaban (2010) (Haryani, 2012) that Mathematics learning can develop students' critical thinking. CONCLUSION The students' mathematical critical thinking skills have improved from cycle to cycle; however the result shown was less satisfactory as there were only half of the number of participants who were able to complete the MCT test successfully.

Generally, the result showed that there was improvement in students' enthusiasm in learning in each cycle, particularly during group discussion. Students were more willing to express their thoughts in front of the class which resulted in better understanding of the lesson. ACKNOWLEDGMENTS We would like to express our highest gratitude to the Principal of SMAN 22 Bandung and the teachers of Grade XI Science 6 who have given us the opportunity to conduct this research. REFERENCES Abdullah, I. H. (2013). Berpikir Kritis Matematik. Jurnal Matematika Dan Pendidikan Matematika, 2(1), 66–75.

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