High Order Thinking Skills: Can It Increase by using Realistic Mathematics Education?

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Abstract. This research aimed to know (1) mathematics learning by realistic mathematics education which increase students's high order thinking skills, (2) the increasing student's high order thinking skills by using realistic mathematics education. This research used classroom action research as the method which consists of four stages: planning, action, observing, and reflection. This classroom action research was conducted in one of the senior high school in Tanjung Morawa, Indonesia. The result of this research indicate that realistic mathematics education can increase students' high order thinking skills. The increasing of students' high order thinking skill can be seen by the mean of score in cycle I which is 61,94 and 86,39 in cycle II. The increasing is also seen in classical completeness in cycle I which is 33,33% and 86,66% in cycle II. The N-Gain in cycle I is 0,42 in medium category and 0,70 for cycle II in high category.

1. Introduction

The very worrying condition of the high order thinking skills of Indonesian students can be seen in the results of the TIMSS and PISA reports. Based on the 2015 TIMMS [1] results report, Indonesia was ranked 45 out of 48 participating countries with a math score of 397 with global average is 505. The 2015 PISA [2] report also showed that Indonesian students' high level thinking skills are still low. Indonesia is ranked 64 out of 72 participating countries with a math score of 386 and global average is 490 points. The two result studies indicate that the ability of Indonesian students to solve non-routine problems and solve complex problems involving high order thinking processes was still very weak even though it did not indicate the overall achievement of Indonesian students in mathematics but by comparing the achievements of Indonesian students based on the results of TIMMS and PISA, it has shown the low quality of mathematics knowledge of Indonesian students at the international level.

Observation that have been made by researchers at SMA Negeri 1 Tanjung Morawa showed that students' high order thinking skills were still low even though the school has implemented high order thinking skills based learning. Based on the observation test of high order thinking skills, it was found that none of the 30 students (0%) had a high order thinking skills with a very high category, there was 1 student (3.33%) who had high order thinking skills with a high category, there was no student (0%) who had a high order thinking skills with a sufficient category, there are 5 students (16.66%) who had a hige order thinking skills with a low category, and 24 students (80%) who had a high order thinking

with very poor category. After doing the observation at the school, researchers conclude that the problems of teacher and students were students could not analyze incoming information and divided or structured information into smaller parts to identify patterns and relationships, students were unable to provide justification by referring to facts mathematically and the ability to provide mathematical arguments, students could not present information in various forms creatively and could not make connections between information and made connections between mathematical ideas, students learning activeness was still lack, and the learning model used by the teacher had not supported to improve high order thinking skills. Thus, it is needed an effort to improve students' mathematical high order thinking skills so that students' achievement increases.

Realistic mathematics education can improve students' high order thinking skills score [3-4]. Activities in realistic mathematics learning, namely solving problems in a contextual manner can encourage students to develop high order thinking skills [5-6]. The abilities that students have through realistic mathematics learning are the ability to contribute, solve problems, creativity, interact, and reflect [2]. Providing contextual problems by doing verification can improve students' ability to analyze. The ability to evaluate can improve by providing contextual problems that lead students to argue. Providing contextual problems that lead students to relate the information provided and forming a new formula will improve students' ability to create [7].

This study was conducted to answer the following questions: 1) how is realistic mathematics education learning that can increase students' high order thinking skill?, and 2) How the enhancement of students' high order thinking skills by using realistic mathematics education?

2. Method

This study is classroom action research which consists four stages: 1)planning, 2)implementation, 3)observation, and 4)reflection. At the planning stage researchers made the learning planning, prepared supporting facilities for the learning activities, and prepared research instruments. At the action stage researchers carried out learning activities by applying realistic mathematics education, provide students worksheet, and at the end of the action, the students' high order thinking skills test was given. At the observing stage, researchers asked the teacher to observe learning activities. At the reflection stage, researchers thoroughly examined the actions that had been taken based on the data obtained from the research instrument and analyzed the difficulties faced by researchers.

This study was conducted at SMA Negeri 1 Tanjung Morawa in 12^{th} grade seudents with the implementation time in the odd semester 2019/2020 academic year. The subject of this study were 30 students, consisting 18 female students and 12 male students. Data collection instruments used in this study were tests and observation guidelines. The performance indicators of this research are 1) the minimum observation result of researchers and students in good category 2) the students' average above minimum completeness (KKM), 3) the achievement of students learning outcomes with 85% of students having grades above minimum completeness (KKM) after the research action, and 4) the minimum of n-gain value in good category.

The data had been obtained will be grouped into the category of students' high oder thinking skills level. The students' high order thinking skills average is converted into a qualitative form by using the assessment guidelines written by Susantiet.al [8] as follows:

Table 1. High Order Thinking Skills Category

Score	Categories
$90 \leq$ Score ≤ 100	Very good
$75 \leq$ Score< 90	Good
$55 \leq$ Score< 75	Enough
$40 \leq$ Score< 55	Less
Score < 40	Poor

To know the category of high order thinking skills improvement researchers used n-gain value. The category of n-gain as follows [9]:

Table 2. N-Gain Value Category

N-gain value	Category
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.7$	Low

3. Results and Discussion

3.1. Implementation of the fist cycle learning

The problem in the first cycle was students' high order thinking skills in mathematics were poor, which of 30 students, none (0%) had a very high level of high order thinking skills, there was 1 student (3.33%) in high category, there was no student (0%) in enough category, there we 5 students (16.66%) in low category, and 24 students (80%) in poor category, while the classical percentage was 3.33%. Several things that need to be considered by researcher as problems were 1) students could not analyze the information provided, 2) students were unable to provide justification, 3) students could not creative in various forms, and 4) students learning activity was still low.

After knew the problems, researchers made planning for the implementation of the learning. In the planning phase researchers did some activities, such as: 1) made learning implementation plan (RPP) which contained learning activity steps through realistic mathematics education, 2) made student activity sheet (LAS) on the mean and mode sub material to practice students' high order thinking skills, 3) made mathematical high order thinking skills tests, and 4) made observation sheets.

After the action planning stage of the first cycle was compiled, the implementation was taken to improve students' high order thinking skills. The implementation consists of carried out learning activities by applying realistic mathematics education approach.

At the same time as the implementation of learning, teacher (observer) observed the learning activities since the beginning until the end of the learning implementation. The results of observation made by the teacher can be seen in the following table.

Table 3. The Results of Observation

Observation	Score	Category
Researchers	2.68	Good
Students	2.5	Low

Based on the table 3 it can be concluded that the result of researchers observation was in good category but the result of students observation was in low category so it does not fulfill the first indicators.

After implementing learning and observing learning activities, researchers analyze the results of students' high order thinking skill. The results as follows:

Table 4. Students' Achievement at The First Cycle

Score	Category	Number of Students	Percentage	Average
$90 \leq$ Score ≤ 100	Very high	2	6.6%	
$75 \leq$ Score < 90	High	8	26.6%	
$55 \leq$ Score < 75	Enough	9	30%	61.94
$40 \leq$ Score < 55	Less	9	30%	
Score < 40	Poor	2	6.6%	

Based on the table 4, there were 2 students (6.6%) in very high category, there were 8 (26.66%) students in high category, there were 9 (30%) students in enough category, there were 9 (30%) students in less category, and there were 2 (6.6%) students in poor category. The average of students'

mathematical high order thinking skills was 61.94, which mean in enough category and not fulfill minimum completeness. Based on the data, researchers analyze the classical completeness in the first cycle. The result as follows:

Table 5. Students' Classical Completeness

Level of Completeness	Number of Students	Percentage
Complete	10	33.33%
Not Complete	20	66.66%

Based on the table 5, it can be concluded that of the 30 students, there were 10 students who achieved learning completeness so that the classical completeness in the first cycle was 33.33% so it did not fulfill the indicator of this study. The researchers also analyze the students' score based on each indicator as follows:

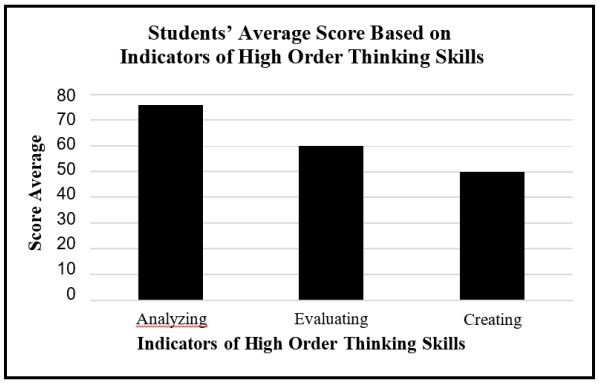

Figure 1. Students' Average Score Based on Indicators

Based on the figure 1, the students' average score in analyzing was 75.8 in high category, the students' average score in evaluating was 60 in enough category, and the students' average score in creating was 50 in less category. Based on the data it can be conclude that the score analyzing was higher than evaluating and creating so reaserchers should more pay attention at the evaluating and creating indicators. Reasercher used n-gain value to know the increasement of students' high order thinking skills score. The n-gain value was 0.45 in medium category so it did not fulfill the indicator of this study.

The end of the stages is reflection. At this stage reasercher conclude the result of the first cycle and analyze the problems at the first cycle implementation. Based on the data, reasercher should continue the learning to the second cycle besause the result did not fulfill the indicators of this study. The problems at the first cycle such as: 1) reaserchers had not beed able to optimally manage and carry out learning activities, 2) students were less careful when answered students' worksheet (LAS) especially in calculation, 3) students were less active in asking questions, expressing ideas or providing opinions or responses, and interaction between groups is still low, 4) the difficulties of students in analyzing indicator were finding the relationship between cencepts and identify or formulate the questions, 5) the difficulties of students in evaluating indicator were providing arguments against the idea in the questions, students were not able to test the idea in the questions, and students were not able to accept or reject a statement based on predetermined criteriaa, and 6) the difficulties of students in creating indicator were generalizing an idea and organizing elements or parts into new structures.

3.2. Implementation in the second cycle

The problems in the second cycle were same as the problems after doing learning process in the first cycle. Based on the problems, teacher should pay attention on the result of observation, the students'

average score, the classical completeness, and the n-gain value so this study can fulfill all of the indicators.

The first stage is planning. At the planning stage, researchers did same action with the planning stage at the first cycle as follows: 1) made learning implementation plan (RPP) which contained learning activity steps through realistic mathematics education, 2) made student activity sheet (LAS) on the mean and mode sub material to practice students' high order thinking skills, 3) made mathematical high order thinking skills tests, and 4) made observation sheets.

The second stage is implementation. The implementation consists of carried out learning activities by applying realistic mathematics education approach but researchers gave more attention based on the problems which discovered at the first cycle. The learning activities that researchers should give more attention were: 1) researchers should practice and learn more about classroom management so that researchers were expected to be better to manage class well, 2) through group discussion, researchers emphasize more on guiding students discussion activities in answering problems in students' worksheet (LAS) and gave a lot of time to review the result of the discussion so students are more careful in calculation, 3) researchers further motivate students to build concepts on themselves to express their opinions or ideas. Researchers gave awards to students who want to express their opinions, 4) researchers were more guiding and giving direction to students to better recognized the relationship between the concepts used in the problem and do not forget to conclude the solution, 5) researcher were more guiding and giving direction to students to provide arguments against the ideas in the questions and accepted or rejected a statement based on predetermined criteria, and 6) researchers were more guiding and providing direction for students to generalize an idea and organize the elements or parts into a new structure.

The third stage is observation. The observation was carried out since the beginning until the end of the learning implementation. The results of observation made by the teacher can be seen in the following table.

Table 6. The Results of Observation

Observation	Score	Category
Researchers	3.37	Good
Students	3.5	Good

Based on the table 6, it can be concluded that the result of researchers observation was in good category and the result of students observation was in good category so it fulfilled the first indicators.

After learning process was end, researchers analyzed the results of students high order thinking skill. The results as follows:

Table 7. Students' Achievement at The First Cycle

Score	Category	Number of Students	Percentage	Average
$90 \leq$ Score ≤ 100	Very high	17	56.6%	
$75 \leq$ Score < 90	High	9	30%	
$55 \leq$ Score < 75	Enough	3	10%	86.39
$40 \leq$ Score < 55	Less	1	3.33%	
Score < 40	Poor	0	0%	

Based on the table 7, there were 17 students (6.6%) in very high category, there were 9 (30%) students in high category, there were 3 (10%) students in enough category, there were 1 (3.33%) students in less category, and there was no (0%) student in poor category. The average of students' mathematical high order thinking skills was 86.39, which mean in high category and fulfilled minimum completeness. Based on the data, researchers analyzed the classical completeness in the second cycle. The result as follows:

Table 8. Students' Classical Completeness

Level of Completeness	Number of Students	Percentage
Complete	26	86.66%
Not Complete	4	13.33%

Based on the table 8, it can be concluded that of the 30 students, there were 26 students who achived learning completeness so the classical completeness in the second cycle was 86.66% so it fulfilled the 3rd indicator of this study. The n-gain value was 0.7 in high category so it did not fulfill the indicator of this study. The researchers also analyze the students' score based on each indicator as follows:

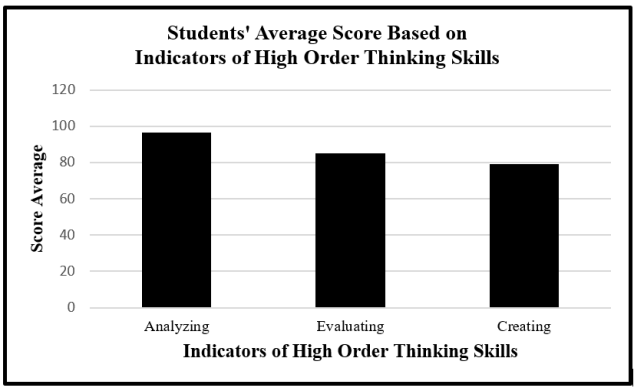

Figure 2. Students' Average Score Based on Indicator

Based on the figure 2, the students' average score in analyzing was 96.67 in high category, the students' average score in evaluating was 85 in high category, and the students' average score in creating was 79.16 in high category. Based on the figure 2, it concluded that analyzing was higher than evaluating and creating. This result was same as the result in the first cycle. This happened because in analyzing students were only required to analyze the information in the problem, be able to recognize complex scenario, and identified/formulated questions. This activity was considered by students as an easy activity, especially during the second cycle because they were better trained in solving problems with analyzing indicator [10].

Evaluating always ranked second in the ability that students could achieve in solving high order thinking skills problems. There are several problems faced by students so the score obtained were not as satisfying as analyzing. The problems that occur to students were unable to provide assessments, unable to criticize, and unable to accept or reject an idea. It is hoped that the next researcher or teacher will pay more attention to the indicator so the score will be more satisfying.

Creating were always in the third order of ability that could be achieved by students in solving high order thinking question. This showed that the ability to creating was the most difficult indicator for students to achieve. The students' problems in this indicator were generalizing an idea or way of looking at something, a way to solve problems, and organize elements or parts into new structure that have never existed before. It is hoped that the next researcher and teacher will pay more attention to this indicator so the score will reach maximum result.

The last stage in this study is reflection. At this stage, researcher conclude the result based on the indicator of this study. The data represented on the table below:

Table 9. Researchers' Achievement in The Second Cycle

Indicator	Score	Completeness
Observation	Researchers (3.37)	Fulfill
	Students (3.5)	Fulfill
Average of students' achievement	86.39	Fulfill
Classical completeness	86.66%	Fulfill
N-gain value	0.7	Fulfill

Based on the table 9, the indicators of this research were fullfilled. The score of observation was 3.37 for researcher and 3.5 for students. The average of students' achievement was fulfilled with score 86.39. Classical completeness was fulfilled with score 86.66%. the n-gain value was fullfilled with score 0.7.

4. Conclusion

Based on the results of this study, researchers can conclude that mathematics learning by using realistic mathematics education can improve students' mathematical high order thinking skills with the subject of statistics occurring after learning in the second cycle by making improvement from the first cycle. The improvements made were researchers asked students to provide arguments about something so it is expected students could write their ideas confidently, researchers raised more confidence in each group and gave appreciation and appointed certain group to provide responses, researchers did more questions and answers with students so they were not confused in giving conclusion. The increasing students' high order thinking skill by using realistic mathematics education can be seen from the class average in the first cycle namely 61.94 to 86.39 in the second cycle. In addition, the increase also occurred in the classical completeness in the first cycle 3.33% to 86.66% in the second cycle. The n-gain value obtained in the first cycle was 0.42 in medium category and in the second cycle was 0.70 in high category.

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