Analysis of higher order thinking skills of SMP students in completing the problem of the numbers through the application of problem based learning

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Abstract. The large number of student complaints in completing the Computer-Based National Exams in 2018 became the beginning of the emergence of new problems in the application of the curriculum 2013. One of the reasons is that students have not used to solve higher order thinking skills. The teacher is also not accustomed to giving these types of questions in classroom learning. Therefore, this study aims to describe the higher order students' thinking skills to solve the Number Pattern problem after the application of problem based learning. Problem based learning with stages: student orientation to problems, organizing students to learn, guiding individual / group investigations, developing and presenting work, analyzing and evaluating problem solving processes. The research method used is descriptive method with a quantitative approach. The research subjects were students of class VIII-1 of SMP Negeri 4 Binjai, totaling 30 people. The data collection technique used is a description test consisting of 5 questions covering the levels of analyzing, evaluating and creating. Based on data analysis, it is known that the higher order thinking skills of students in solving problems with Number Patterns after the implementation of problem based learning are in the good category.

1. Introduction
Education is one of the activities that can change the mindset of humans. Education is important if you do not want to be left behind by other countries in the world [1]. Learning mathematics is an important part of education. Mathematics Learning helps students to be able to improve their thinking abilities. Education in the era of the industrial revolution 4.0 is directed at developing 21st century competencies which consist of three main components namely thinking competency, creative thinking and problem solving abilities [2]. Learning oriented towards improving students' thinking and character skills expressed in the 2013 curriculum.

The implementation of the 2013 curriculum in general uses a scientific approach in the learning process. The scientific approach in question is a learning activity that is designed so that students actively construct concepts, laws or principles through the stages of the 5M activity in the core learning activities. The core learning activities according to the 2013 curriculum must contain 5M activities, namely observing, asking, trying, reasoning and communicating [3].
In fact the implementation of the 2013 curriculum is still not optimal where there are still teachers who have not been able to follow the expected learning system. Learning is still teacher-centered, not student-centered. Problems given are also routine problems. Although in solving mathematical problems there are still many students who have difficulty [4].

The problems given in classroom learning are not higher order thinking problems as expected in the 2013 curriculum. Students are not yet accustomed to solving HOTS questions. This can be seen when students complete the National Examination questions where the questions consist of several HOTS type questions. Students have difficulty completing it. Students are not accustomed to solving HOTS questions, because the teachers is also not accustomed to giving HOTS questions in the learning done.

According to Bloom's revised taxonomy cognitive processes are divided into low-level thinking abilities and high-level thinking abilities. The ability that includes LOT is the ability to remember, understand and apply, while HOT includes the ability to analyze, evaluate and create [5].

Constructivism learning theory is a learning theory that is able to develop students' abilities. Students construct their knowledge by interacting with the environment and through the knowledge they already have. One learning model that is in accordance with the theory of constructivism and the 2013 curriculum is a problem based learning model. The problem based learning model is also one of the learning models that can develop students' high-level thinking skills. Where PBL makes the problem as the beginning of learning, so that it can use HOTS as a problem that will be given to students. The PBL that has been characterized by the fact that problems become the starting point in the learning process becomes the means for training the students' capacity in understanding the problem [6] [7].The syntaxes of PBL-based learning process are namely: (1) orienting the students toward the problems; (2) organizing the students to learn; (3) guiding the students to perform investigations both individually and collectively; (4) developing and presenting the problem-solving procedure; and analyzing and evaluating the problem-solving process [8].

The problem in this study is that students are not accustomed to completing HOTS questions in learning with the 2013 curriculum, so students' higher order thinking skills are still not optimal. Therefore, this study aims to describe the higher order thinking skills of SMP students to solve the Number Pattern problem after the application of problem-based learning. The results of this study can be a source of inspiration for teachers to measure the HOTS of SMP students.

2. Methods

This research is descriptive research with a quantitative approach. The purpose of the study was to describe the HOTS of SMP students on the material of Number Patterns after the application of Problem Based Learning. The study was conducted at SMP Negeri 4 Binjai Jalan Bejomuna No.66 which is located in the city of Binjai, North Sumatra, Indonesia. The research subjects were students in SMP Negeri 4 Binjai in class VIII-1 of the 2019/2020 school year, totaling 30 people. The object of this study is HOTS students on the material of Number Patterns with problem based learning.

The variable in this study is Higher Order Thinking Skills (HOTS) SMP students. The ability to think at a high level can make an individual interpret, analyze or manipulate information. With the ability to think at a high level, students can distinguish ideas or ideas clearly, are able to solve problems, argue well, be able to hypothesize and understand complex things become clearer [9]. Indicators of higher order thinking ability in this study are identifying and linking relevant data / information from a situation or problem to making appropriate conclusions from a collection of data / information, assessing the quality / accuracy of a statement or argument, detecting consistency and
inconsistencies in a process / product accompanied evidence, construct ideas / strategies and use them to solve problems develop new suspicions and alternatives in solving problems [10].

The research instrument used to measure students' HOTS is a test. The test consists of 5 questions of Number Patterns according to the indicators of HOTS ability that have been explained previously. The test is first validated by a team of experts in this case one teacher and one lecturer. Student test result data is processed through data analysis activities. Data is processed using the formula:

\[
\text{Score} = \frac{\text{Number of Scores Obtained}}{\text{Maximum number of Scores}} \times 100
\]

Based on the score above, each student's score is obtained. Criteria for making decisions on these scores can be seen in the following table:

| No. | Interval   | Category of Score   |
|-----|------------|---------------------|
| 1.  | 80 – 100   | Very Good           |
| 2.  | 61 – 80    | Good                |
| 3.  | 41 – 60    | Sufficiently Good   |
| 4.  | 21 – 40    | Less                |
| 5.  | 81 - 100   | Very Less           |

To calculate the percentage of students who have the ability to think at a high level according to the criteria, the following formula is used:

\[
\text{Percentage} = \frac{\text{Number of Students with certain Criteria}}{\text{Total Students}} \times 100\%
\]

3. Result and discussion

Problem based learning on material number patterns is done as many as 5 meetings with each meeting giving HOTS problems. Problem-based learning begins with the initial stage, namely student orientation to the problem. At this stage, students are given HOTS questions in the worksheet that has been provided by the teacher and students are asked to understand the problem. The second stage, organizing students to learn. At this stage, students are welcome students to ask questions related to the worksheet. The third stage, guiding individual / group investigations. The teacher provides an opportunity for students to investigate the HOTS problem in the worksheet. The teacher motivates students to use their own models and methods in accordance with the mathematical knowledge they already have. The teacher as a facilitator in learning goes around from group to group observing and encouraging students to think of other possibilities for students' answers.

The fourth stage, developing and presenting the work. The teacher invites students to gather information needed in other learning resources to develop understanding of the problem so that a solution to the problem is obtained in the worksheet. The teacher invites several groups in turn to come to the front of the class to present their group's answers. The teacher invites students to ask questions related to student presentations. The fifth stage is analyzing and evaluating the problem solving process. The teacher guides students to analyze the HOTS problem solution that is displayed in front of the class. The teacher guides the discussion to evaluate the results of students' answers.

3.1. The validity of the HOTS Test
The test instrument used in this study consisted of 5 HOTS questions. The test was validated by two teachers and two lecturers in the field of mathematics education. Following are the results of the validation of the Number Pattern material test.

**Table 2. Number Pattern Test Validation Results**

| No | Rated aspect                                      | The Amount of Validator Gives | Mean |
|----|--------------------------------------------------|-------------------------------|------|
|    |                                                   | Value                         |      |
| 1  | Format                                           |                               |      |
|    | a. Neatness in typing                           | 1 2 1 4                       |      |
|    | b. Spatial / layout settings                     | 2 2 4.5                       |      |
|    | c. Appropriate type and font                     | 3 1 4.25                      |      |
| 2  | Language                                         |                               |      |
|    | a. Truth and grammar                            | 2 1 1 3.75                    |      |
|    | b. Simplicity of sentence structure              | 2 2 4.5                       |      |
|    | c. Clarity of instructions and direction         | 3 1 4.25                      |      |
|    | d. The communicative nature of the language used| 1 2 1 4                       |      |
|    | Content                                          |                               |      |
|    | a. Material truth                                | 3 1 4.25                      |      |
|    | b. Problems presented in accordance with indicators of higher order thinking skills | 1 3 4.75 |      |
|    | c. Appropriate time allocation used              | 2 2 4.5                       |      |
|    | d. Eligibility as a research instrument          | 1 3 4.75                      |      |
|    | Mean                                             |                               | 4.31 |
|    | Validation Results                               |                               | Very Valid |

Based on table 2 above, the average validity score is 4.31. This means that the number pattern test is very valid to be used as a test instrument in this study. Thus, the number pattern tests that have been prepared are appropriate to be used as test instruments to measure the thinking ability of high-level junior high school students.

3.2. Analysis Higher Order Thinking Skills SMP Students

The application of problem based learning on the subject of number patterns is done in 5 meetings. After the meeting ends, the sixth meeting tests. The purpose of the test is to measure students' high-level thinking skills on the subject of number patterns that have been learned with problem-based learning. Students are given approximately 2 learning lessons, namely 2x40 minutes.

Student test results are then examined and then analyzed. The results of data analysis obtained are presented in the following table:
Table 3. HOTS Percentage of SMP Negeri 4 Binjai

| Interval | Category of score   | Students | Percentage |
|----------|---------------------|----------|------------|
| 0-20     | Very Less           | 0        | 0          |
| 21-40    | Less                | 2        | 6.67       |
| 41-60    | Sufficiently Good   | 12       | 40         |
| 61-80    | Good                | 13       | 43.33      |
| 81-100   | Very Good           | 3        | 10         |
| Total    |                     | 30       | 100        |

Based on table 3 above, it was found that students with high level thinking skills were less than 2 people (6.67%), students with high level thinking skills were enough as many as 12 people (40%), students with high level thinking skills were good 13 people (43.33%) , students with high levels of thinking ability are very good at 3 people (10%). This shows that there are still students who have not been able to think at a high level.

Based on the diagram above, it is found that students with the ability to think at a high level in the Good category are in first place. This means that students of SMP Negeri 4 Binjai have good high-level thinking skills. This high-level thinking ability is obtained after problem-based learning on the subject of number patterns.

3.3. Analysis of Higher Order Thinking Abilities Based on Bloom's Taxonomy
Students' higher order thinking skills can be categorized based on bloom's taxonomy, namely the ability to analyze, evaluate and create. The test given is a higher order thinking ability test containing questions that require students to have the ability to analyze, evaluate and create. The results of the
analysis of students' higher order thinking tests on each question based on Bloom's taxonomy are as follows:

| Capability | Item 1 | Item 2 | Item 3 | Item 4 | Item 5 |
|------------|--------|--------|--------|--------|--------|
| Analyzing  | 10     | 20     | 15     | 12     | 17     |
| Evaluating | 17     | 9      | 12     | 17     | 11     |
| Creating   | 3      | 1      | 0      | 1      | 2      |
| Total      | 30     | 30     | 27     | 30     | 30     |

Based on the table above, it appears that most students master the ability to analyze and evaluate. However, only a few students are able to create. This is in accordance with the percentage of analysis results of higher order thinking ability with very good criteria of only 3%.

In question number 1 10 students were able to analyze, 17 were able to evaluate and 3 students were able to create. In problem number 2 as many as 20 students were able to analyze, 9 people were able to evaluate and only 1 person was able to create. In question number 3, 15 people were able to analyze, 12 people were able to evaluate and no one was able to create. In question number 4, 12 students were able to analyze, 17 students were able to evaluate and only 1 student was able to create. In problem number 5 17 students were able to analyze, 11 students were able to evaluate and only 2 students were able to create.

The results of this study indicate that the higher order thinking ability of SMP Negeri 4 Binjai students is in the good category. Although there are still students who have not been able to think at a high level. Based on this research it can also be concluded that the ability to create is an ability that is difficult for students to have. The results of this study are in line with previous research conducted by Anjani (2017) which shows that there is not a single student who has the ability to create [11]. This means that students are still not able to create an idea, or new ideas in answering the questions given.

4. Conclusion
Learning is done with the syntax of Problem Based Learning. Students participate in learning activities very well. Students solve HOTS problems given in learning so that students are accustomed to solving HOTS problems. This helps students to be able to take the HOTS test on the subject of number patterns. The results of the analysis obtained that students' high-level thinking ability on the subject of number patterns after the implementation of problem-based learning that students are in good category. This shows that problem-based learning is well used in learning the 2013 curriculum. Thus, it is hoped that learning mathematics in the 2013 curriculum will be better.

Acknowledgment
Thank you, the authors extend to the Ministry of Research, Technology and Higher Education (Kemenristekdikti) of the Republic of Indonesia for the support and assistance of research funds in the 2019 Academic Year Beginner Lecturer Research scheme that has been provided with agreement letter number T / 87 / L1.3.1 / PT.01.03 / 2019. Hopefully the results of this study will be useful for the development of Indonesian education science
References

[1] Imelda 2018 Application of the Problem Solving Method in improving problem solving skills in algebra and trigonometry courses MES (Journal of Mathematics Education and Science 3(2) pp 159-166.

[2] Kemendikbud 2019 Module for Preparation of Mathematical Higher Order Thinking Skills Jakarta: Kemendikbud.

[3] S D Simanjuntak and Imelda 2018 Student Activities in Realistic Mathematics Learning using the Context of the Toba Batak Culture Seminar Nasional Matematika dan Terapan pp 99 – 103.

[4] Imelda 2018 Analysis of Student Difficulties in Solving Problem Solving Problems in Algebra and Trigonometry Courses MES (Journal of Mathematics Education and Science 4(1) pp 49 - 56.

[5] Nurhayati and L Angraeni 2017 Analysis of Students' High-Level Thinking Ability in Solving Optical Concept Problems through Problem Based Learning Model JPPPF-Jurnal penelitian dan Pengembangan Fisika 3(2) pp 119 – 126.

[6] Hmelo-Silver C E 2004 Problem-Based-Learning: What and how do students learn Educational Psychology Review 16(3) pp 235-266.

[7] Sungur S and Tekkaya C 2006 Effects of Problem-Based-Learning and Tradisional instruction on self-regulated learning The Journal of Educational Research 99(5) pp 307-320.

[8] Jailani J, Sugiman S and Apino E 2017 Implementing the problem-based learning in order to improve the students’ HOTS and characters. Jurnal Riset Pendidikan Matematika 4(2) pp 247-259.

[9] Widodo S A 2013 Error Analysis in Solving Type Divergence Problems Proving to Mathematics Students Jurnal Pendidikan dan Pengajaran 46(2) pp 106-113.

[10] S Musfiqi and Jailani 2014 Development of Mathematics Teaching Materials Oriented on Character and Higher Order Thinking Skills (HOTS) Pythagoras Jurnal Pendidikan Matematik 9(1).

[11] Anjani Y F 2017 Analysis of Higher-Order Thinking Abilities According to Anderson and Krathwohl's Theory in Students of Class XI Bilingual Class System MAN 2 Kudus at the Subject of Linear Programs Universitas Islam Negeri Wali Songo.