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# Higher Order Thinking Skills of Mathematics Education Department Students of Hasyim Asy'ari University in Solving the Problem of Generator Function in Discrete Mathematics Lecture

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Keywords: HOTS, Problem Solving, Discrete Mathematics

Abstract: This research aimed at describing students' higher order thinking skills in solving the problem of generator function. Higher Order Thinking Skills (HOTS) in this research consisted of logic and reasoning, analysis, evaluation, and creation skills. This research was a descriptive research by using qualitative approach. Meanwhile, the research subject was three students of mathematics education department of Hasyim Asy'ari University,one student with high ability, one student with medium ability, and one student with low ability.The data collecting method used was test, scoring rubric, and interview. Then, the data validation technique used was tie triangulation. To analyze the data, the researcher used Miles and Huberman concepts consisting of data reduction, data interpretation, and conclusion making. The conclusion of this research shows that one student do the skills of logic and reasoning, analysis, evaluation, and creation not very well in solving the problem of generator function, so that, they are included in the medium level of high order thinking skills. Next, two students cannot do the skills of logic and reasoning, analysis, evaluation, and creation well in solving the problem of generator function, so that, they are included in the low level of high order thinking skills.



## 1 INTRODUCTION

The abilities of learning, improving performance, and reducing weaknesses belong to students with HOTS because learning effectiveness, learning speed, and learning ability are affected by the thought of a person (Yee, Othman, Yunos, Tee, Hasan, and Mohammad, 2011). Furthermore, Kings, Goodson, and Rohani (2013) state that HOTS are students' ability to think not only by remembering but also by encountering unfamiliar problems, uncertainties, questions, or dilemmas. Moreover Pogrow (2005) argues that students' success can be predicted by HOTS owned by them because by having HOTS can make students face advanced academic life and adult's work and responsibility in daily basis better.

Moore and Stanley (2010) state that Higher Order Thinking Skill is the last three aspects of Bloom taxonomy consisting of analysis, evaluation and creation. According to Brookhart (2010), Higher Order Thinking Skills cover skills of logic and reasoning, analysis, evaluation, creation, problem solving and judgment.

Anderson and Krathwohl (2001) say that analysis skill in HOTS is a skill to find a problem, then it needs to rebuild the thing becoming the problem and identify the most important and relevant part of the problem, next it is continued by building an appropriate relation to the given information. Meanwhile, evaluation skill consists of planning how far a plan works well and criticizing to a product or operation assessment based on external criteria and standards. Next, creation skill in HOTS is a skill to present the problem, finding of alternative hypothesis needed and planning to solve the problem given. Reasoning skill is thinking proses and concluding in the form of knowledge. HOTS in this researchare skills of logic and reasoning, analysis, evaluation also creation.

Same researches deal with HOTS of student have been conducted araund the world. Tajudin (2015) conducted studies in mathematical knowledge and higher order thinking skills for teaching algebraic problem solving in Turkey. Next, Yen and Halili



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(2015) conducted the study of effective teaching of higher order thingking (HOT) in education.

Discrete mathematics is a part of mathematics that studies different and separated objects. Generally, discrete mathematics is used to count many objects, study the relationship between finite sets and analyze process that engages infinite steps (Rahmawati, 2016). One material that is considered difficult by students in discrete mathematics course is generator function. The research that was conducted by Podilito (2015) explains that students have not been able to formulate the problem solving steps correctly and systematically.

In mathematics learning, problem solving is a way to think. It means that students cannot just rely to what they learn to be able to solve a problem without structured process. Even though, some students may be able to solve the problem well, most of them should learn how to find the reason and how to solve the problem. Whereas according to Rahmawati (2015), problem solving is a learning approach that stimulates students to want to think, analyze a problem so that it can determine its solution. In line with this, Ersoy (2016) explains that Problem solving plays an important role in mathematics education since it increases the students' high level thinking by having self-learning. The purpose of this research is to describe students' HOTS in solving generator function problem based on arranged indicators.

## 2 METHODS

This research on students' HOTS in solving the problem is a descriptive research with a qualitative approach. This research includes descriptive research because the researcher just analyzes up to description step. It is analyzing and presenting the facts systematically (Azwar, 2007). While according to Sugiyono (2011), qualitative research method is research method that is used to conduct the research about natural object condition, the researcher as a key instrument, triangulation as the data collection technique, inductive/ qualitative data analysis, and the emphasize of qualitative research result on meaning more than generalization.

This research subjects are mathematics students having taken discrete mathematics course. They are 3 students in the semester 5 of mathematics education department, Hasyim Asy'ari University. So, the data of Students' HOTS in solving the problem achieved is expected to be able to represent the real condition in the field. Subject selection uses purposive sampling technique based on students' ability determination on their midterm test, final test, and task score given by the lecturer of generator function. Meanwhile, the research is conducted at department of mathematics education classroom in a conducive condition, so that the students focus to explain what is to be a problem in solving the problem at the generator function in detail.

In research there must be a valid research instrument. Before the researcher conducts research, the researcher must make a research instrument.The main instrument and supporting instrument are used to get HOTS category data. The main instruments are the researchers themselves as planners, data collectors, data analyzers, data interpreters, and research result reporters. Supporting instruments are test questions, assessment rubric and interview guidelines. Test questions are given in this research in the form of worksheet that is done by the students individually. It is done to find HOTS description in solving generator function problem from the researchers. Then the instrument is validated to the validator. In the results of the validation test, the researcher conducted an analysis of the results to determine the validity level.

Data validity technique that is used in this research is time triangulation. Data analysis technique used in this research is Miles and Huberman concepts; such as reduction, data presentation and conclusion making. HOTS score from each student is the students' total scores gained based on the number of reactions to the problem/ question that occur when they complete the test question and interview. Maximum score is the highest score of assessment rubric on every HOTS multiplied by the number of test question, while minimum score is the lowest score of assessment rubric on every HOTS multiplied by the number of test question. If the maximum and minimum score have been gained, so the step to categorize the HOTS in high, middle and low level is by determining data range and dividing it into 3 parts, so that high, middle and low class interval is got in sequence reflecting high, middle and low level students' HOTS categories.

## 3 RESULTS AND DISCUSSION

Score result gained from generator function solving problem and interview answers, is used in determining students' HOTS level. From the Students' HOTS test and interview results covering logic and reasoning, analysis, evaluation and

creation aspects, the lowest and highest score are obtained in sequence; 30 and 42. The score is used to determine students' HOTS level categories presented in the table 1.

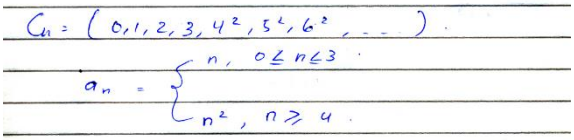
Table 1: Students' HOTS score categories.

| No | Score | Categories |
|---|---|---|
| 1 | $20 \leq$ skor $\leq 34$ | Low |
| 2 | $34 \leq$ skor $\leq 48$ | Middle |
| 3 | $48 \leq$ skor $\leq 62$ | High |

The research result that is gained from 3 research subjects is that there is no student with high level of HOTS, one student with middle level of HOTS, who has less ability in doing logic and reasoning, analysis, evaluation and creation skills well in solving generator function problem, and two students with low level of HOTS, who cannot do logic and reasoning, analysis, evaluation and creation skills in solving generator function problem. Based on interview transcript results, they can represent middle and low level of HOTS.

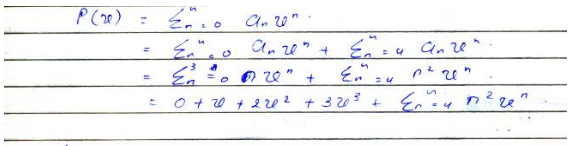
## 3.1 Middle level of HOTS

The result based on data analysis is that a student with middle level of HOTS is good at analysis skill of both first and second problems; this student can identify the main idea by stating thing known and asked on the questions clearly, shortly and appropriately. Next, she can give theoretical reason in every answering step to the last answer correctly. Additionally, she can give the similarity, difference and usage known to answer the question correctly. The following is the example of answer sheet from students:

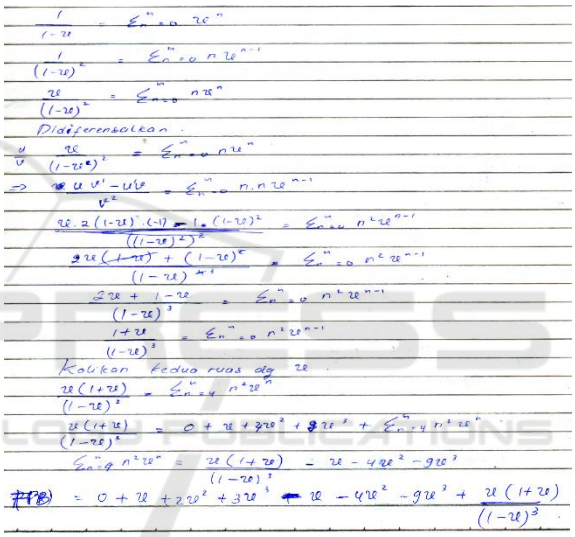


In evaluation skill of both first and second problems, the student is able to give assessment to the solution and method used in answering the questions appropriately. Next, the student criticizes the arguments appropriately to the questions. The student is also able to recheck starting from the thing known to the conclusion of the answer by considering theoretical aspects of answering steps appropriately to the questions.

In creation skill of both first and second problems, the student can design how to answer the questions correctly. The following is the example of answer sheet from students:



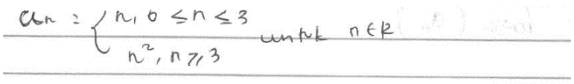
Then, the student designs the way to answer the question correctly by considering the first analysis on the thing known and asked in the questions. The student is also able to make new answering step by combining previous answering steps logically and theoretically on the questions. The following is the example of answer sheet from students:



In logic and reasoning skills, both the first and second problems, student can write the answer content, evidence and reason, and language style clarity effectively, well and logically in finishing the questions.

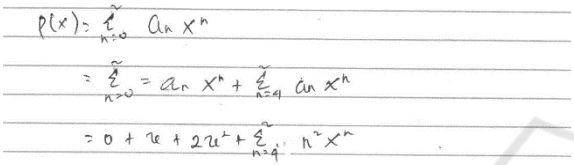
## 3.2 Low Level of HOTS

The result based on data analysis is that students with low level of HOTS in analysis skill of both first and second problem, the two students have not been able to identify the main idea by stating the thing known and asked on the questions clearly, shortly and appropriately. Next, they are not able to give similarity, difference, and usage known to answer the questions correctly. The following is the example of answer sheet from students:

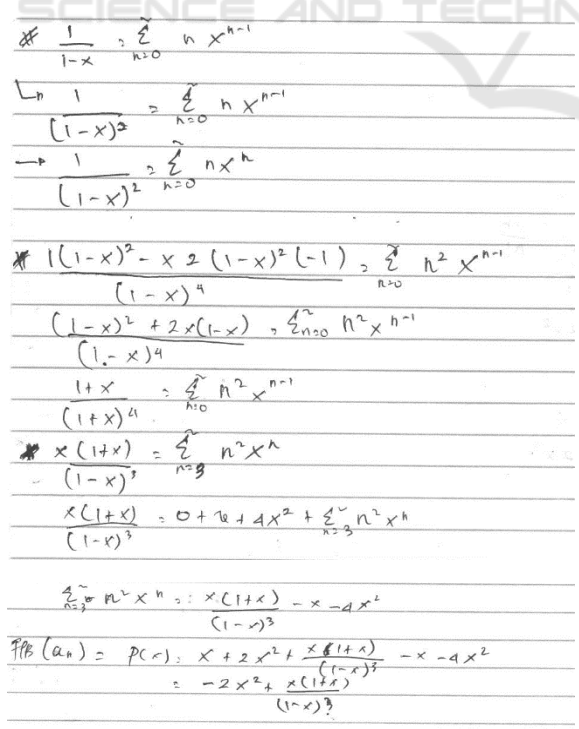


In evaluation skill of both the first and second problems, they are also not able to give evaluation on the solution and method used in answering the questions correctly. But, they criticize the argument the questions correctly. Then students also are not able to recheck the answer from the start to the conclusion by considering theoretic al aspect of answering steps correctly to the questions.

In creation skill of both the first and second problems, they cannot design how to answer the questions appropriately. The following is the example of answer sheet from students:



Next, the students are not able yet to design the way by considering the first analysis on the thing known and asked of questions. They cannot make new answering steps by combining previous answering steps logically and theoretically on the questions.The following is the example of answer sheet from students:



In logic and reasoning skill of both the first and second problems, the students cannot write the answer content, evidence and reason, as well as language style clarity effectively, well and logically to answer the questions.

The test and interview results show that there is correlation between analysis, evaluation, and creation skills. Creation skill is affected by analysis and evaluation skills. So, the requirement for the students to be able to do creation is if the students have been able to do the analysis and evaluation skills at first. This is in line with Anderson's opinion in A Taxonomy for Learning, Teaching and assessing: A Revision of Bloom's Taxonomy of Educational Objectives (2001), creation as the highest part of cognitive domain.

# 4 CONCLUSIONS

Based on the research result, the research conclusions are as follows:

First, the student with middle level of HOTS is able to identify the main idea, analyze an argument, and show the usage of the thing known to answer some questions, so she has quiet good analysis skill. She is also able to give assessment to the solution and methods used and recheck the questions, it means that the student has quite good evaluation skill. The student also can design how to answer and show well to the questions. Thus, it can be said that she has good creation skill. While on their logic and reasoning skill, the student can write the answer content, evidence and language style clarity logically, well and effectively.

Second, the students with low level of HOTS have less ability in identifying the main idea, analyzing the arguments, and showing the usage of the thing known to answer some questions, so they do not have good analysis skill. The students also have less ability in giving assessment to the solution and method used also rechecking to the questions, so they do not have good evaluation skill. The students also are not able to design how to answer and show well to the questions, so they have less good creation skill. While on their logic and reasoning skill, the students have less ability in writing the answer content, evidence and language style clarity logically, well and effectively.

This research was conducted in Hasyim Asy'ari University which still has few students so that it is suggested to do the research with more research subjects because the more subject collection, the

more possible to describe HOTS on students in solving generator function problem.

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## APPENDIX

Indicators to measure students' high-order thinking skills can be seen in the following table:

| **Component of High level thinking skill** | **Indicator of high-level thinking skills in solving problems** |
|---|---|
| Analysis | 1. Students are able to identify the main ideas by stating things that are known and asked about the questions clearly, concisely, and precisely.<br>2. Students provide theoretical reasons for each step of the work until the final answer is correct.<br>3. Students provide similarities, differences and uses of things that are known to answer questions correctly. |
| Evaluation | 1. Students provide an assessment of the solutions and methods used in answering questions correctly.<br>2. Students criticize the argument correctly on the question<br>3. Students re-check starting from the things that are known to the conclusion of the answer by paying attention to the theoretical aspects of the work steps right on the question. |
| Creation | 1. Students design work methods to answer questions correctly.<br>2. Students design ways by considering the initial analysis in terms of known and asked questions.<br>3. Students make a new step in the process by combining the previous work steps logically and theoretically into the problem |
| Logic and reasoning | 1. Students write the content of the answers, evidence and reasons and clarity of the language style effectively, well and logically in solving the problem. |