Student’s Difficulties in Solving Higher Order Thinking Skills (HOTS) Problem for Mathematics Based on Verbalizer Cognitive Style

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Abstract Higher Order Thinking Skills (HOTS) problem for mathematics is mathematics problems related to real life and contain elements of analysis, evaluation and creation. This distinction raises the characteristic of thinking in every student called the cognitive style. The aims of this research is to describe student’s difficulties in solving HOTS problem based on verbalizer cognitive style. This research used the qualitative descriptive method, research subjects are 2 students of VII grade Surakarta with verbalizer cognitive style which selected using purposive sampling. Based on the findings, students with a cognitive style verbalizer begin to have difficulty in solving HOTS mathematics problems at the stage of defining goals by expressing problems in a diagram, where diagrams can help solving the problems.

1. Introduction
Mathematics is important as a basis for studying various disciplines. Mathematics is able to guide students in learning various types of knowledge including languages and non-languages to find mathematical ideas [1]. Mathematics can help students handle complex problems in today's digital era [2]. Mathematics is a subject that helps in technological development, influences the way of thinking of individuals and provides problem solving techniques [3].

Problem solving is an important component in mathematics. Problem solving is one way to give students the opportunity to develop a deeper understanding of mathematics concepts and various ways to represent mathematics solutions [1]. The process of solving mathematical problems follows four basic stages: problem formulation, solution planning, solution design, solution testing, and evaluation [4]. Five types of knowledge are needed to solve mathematical problems: (1) Factual knowledge, namely knowledge of the characteristics of the problem elements, (2) Schematic knowledge that is knowledge of the type of problem, (3) Strategic knowledge that is knowledge of general methods 4) Procedural knowledge, namely knowledge of processes, (5) Knowledge of attitudes, namely beliefs about one's mathematical problem solving abilities [5].

Based on Bransford and Stein there are five components of problem-solving. Components of the Bransford and Stein problem solving model are expressed by an acronym, IDEAL. The component of the IDEAL problem solving model namely, (1) Identify Problems and Opportunities, in this
component the problem is identified and changed into an opportunity to solve the problem, (2) Define Goals, in this component the goals are identified to find alternative solutions to problems so that information can be found that is relevant to the strategy. (3) Explore Possible Strategies, in this component, alternative approaches are identified to solve problems by re-analyzing goals and adding consideration to choices or strategies that can be used to achieve these goals (4) Anticipate Outcomes and action, after the strategy is chosen, it is important to anticipate possible outcomes and then solve the problem with that strategy, (5) Look and learn, in this component the answers are re-examined, discussed and developed for other situations [6]. The IDEAL problem solving framework is easy to understand and applies to realistic problems and can be used to improve student thinking [6]. Therefore, in this study, IDEAL problem solving was used to describe students’ difficulties in solving HOTS problems.

In the process of solving mathematical problems, students acquire ways of thinking, habits of persistence and curiosity, and beliefs in foreign situations that serve them well outside the mathematics class [7]. Thinking ability has a role in interpreting the situation in the problem-solving process so that when students face unusual problems, it takes high-level thinking skills [8]. Higher Order Thinking Skills (HOTS) is a concept of education reform based on Bloom’s Taxonomy with the idea that some types of learning require more cognitive processing than others, but also have more general benefits and involve complex judging skills such as problem-solving [9]. HOTS is very important to study considering the PISA study results in 2015 that the test uses HOTS problems, Indonesia was ranked 69th out of 76 countries [10]. The dimensions of HOTS based on Bloom's Taxonomy revised by Anderson & Krathwohl (2001) namely, analyze, evaluate, and create [10]. In this research, HOTS problem for mathematics is mathematics problems related to real life and contain elements of analysis, evaluation and creation. HOTS problem for mathematics is mathematics problems related to real life and contain elements of analysis, evaluation and creation.

Individual has a different thinking style in the process of solving a problem. This becomes a typical way for students to learn, both related to the way in which information is received and processed, attitudes toward information and habits related to the learning environment are called cognitive styles [12]. Cognitive style is defined as a typical way for individuals to think about gathering, processing information and solving problems. Cognitive style reflects the intellectual and personality aspects of human behavior [13]. Cognitive style refers to individual characteristics and tendencies in feeling, remembering, organizing, processing, thinking, and solving problems [14].

Cognitive style is a trait that is relatively permanent which refers to the typical individual or habitual mode of processing information [15]. There are types of cognitive styles, namely, Field-Independent/Field-Dependent, Reflection / Impulsivity, and Verbalizer-Visualizer [16]. The cognitive style discussed in this study concerns the verbalizer cognitive style, because and not many researchs have discussed the cognitive style of verbalizers in mathematics. In line with the HOTS problem which is interpreted as a mathematical problem related to real problems by presenting using logical words. Verbalizer considers information they read, see, or listen to in verbal words or associations; whereas readers read, listen or consider information [17].

Based on the previous explanation, knowing students' thinking is very important to help students understand mathematics problems. The researchers need to do research related to solving HOTS problems for mathematics. The purpose of this study is to describe student’s difficulties in solving HOTS problem for mathematics based on verbalizer cognitive style.

2. Methods
This research uses the descriptive qualitative method in the form of case studies. The results of the study illustrate the ability of students to solve Higher Order Thinking Skills (HOTS) problem for mathematics based on verbalizer cognitive style. The subjects in this study were 2 students of VII grade in Junior High School which is this school is one of the best schools in Surakarta. The subject was taking using purposive sampling. Subjects are chosen based on students with verbalizer cognitive style, and then the subject can be improved depending on research needs. Verbalizer cognitive style
category was obtained based on a questionnaire developed by researchers based on visualizer-verbalizer questionnaire (VVQ) written by Mendelson [18]. Subject retrieval is also based on consideration of the mathematics teacher.

Techniques Data collection in this research includes tests and interviews. The test in this study uses set problems that contain HOTS elements. The results of this test are the students' difficulties in solving the HOTS problem set material described based on IDEAL problem solving of Bransford and Stein. Interviews were conducted on the selected subject. Each subject is given an in-depth question based on the results of their work in solving HOTS problems of set material. Data analysis techniques in this study are data reduction, data presentation, and conclusion drawing. Data is validated using data triangulation. Data triangulation is done by comparing test results with interviews.

3. Results and Discussion

Subject selection was done by giving VVQ questionnaire to 32 students of VII grade in Junior High School which is one of the best schools in Surakarta. Then 2 subjects are chosen with the verbalizer cognitive style based on the needs of the researcher and the consideration of the mathematics teacher.

HOTS problem in set material

Interviews of 40 newspaper readers are known to 5 people like to read newspapers about politics and sports, 9 people who do not like both. The number of readers who like sports newspapers are twice as the number of readers who like political newspapers. The number of readers who like sports newspapers are ...

The IDEAL problem solving framework is easy to understand and applies to realistic problems and can be used to improve student thinking [6]. Therefore, in this study, IDEAL problem solving was used to describe students' difficulties in solving HOTS problems Analysis of student's difficulties in solving HOTS problems based on IDEAL problem solving of subjects are shown as follows.

![Figure 1](image1.png)

**Figure 1.** The answers of Subject 1 with verbalizer cognitive style

**Identify Problems and Opportunities**
Figure 1 shows that subject 1 is able to identify and understand the problem. The subject is able to write down what is known from the problem.

**Define Goals**

Figure 1 shows that the subject sets goals and explores the problem by presenting a problem in the venn diagram. In the venn diagram there is an error in associating each information. It is better, if \( x \) represents the number of readers who like political newspapers, then the correct answer to represent the number of readers who like sports newspapers is \( 2x \). Subject 1 does not mention variable \( x \) as a variable for many readers who like political or sports newspapers.

**Explore Possible Strategies**

Figure 1 shows that subject has difficulty in determining the strategy to solve HOTS problem. Based on the results of interviews, confused students bring problems into mathematical models, so the subject has difficulty operating calculations. The subject was unable to find other information from the venn diagram. The subject wrote in the venn diagram that the number of readers who like sports newspapers is \( x \), the correct mathematical model for the number of readers who only like sports newspapers is \( 2x - 5 \).

**Anticipate Outcomes and action**

In this stage, as shown in Figure 1 the subject did not find the correct answer. The subject is confused in processing calculations because he is wrong in writing mathematical models. The correct mathematical model of the HOTS problem is \((x - 5) + (2x - 5) + 5 + 9 = 40\). The subject understands that to determine the number of readers who like sports, the subject must know the number of readers who like politics then the results are multiplied by two. In Figure 1 it can be seen that the subject is wrong in determining the number of readers who like politics so they are unable to answer questions correctly.

**Look and learn**

Figure 1 shows subject 1 does not conclude the answers that have been obtained from the calculation. Subjects have difficulty in reviewing answers. The results of the interview indicate that the subject cannot explain in detail the stages of solving the problem that has been done.
Identify Problems and Opportunities
Figure 2 shows that subject 2 is able to identify and understand the problem. The subject is able to write down what is known from the problem.

Define Goals
Figure 2 shows that subject 2 does not present a venn diagram to set goals and explore problems. Subject 2 adds information by writing variable $x$ to represent the number of readers who like political newspapers and $2x$ to represent the number of readers who like sports newspapers.

Explore Possible Strategies
Figure 2 shows that subject has difficulty in determining the strategy to solve HOTS problem. The subject 2 does not understand the concept of the set. Based on the results of interviews, the subject was confused to associate information that states "many readers like both". Therefore subject 2 wrote the mathematical model incorrectly, so the subject has difficulty operating calculations.

Anticipate Outcomes and action
In this stage, as shown in Figure 2 the subject did not find the correct answer. The correct mathematical model of the HOTS problem is $(x - 5) + (2x - 5) + 5 + 9 = 40$. The subject 2 understands that to determine the number of readers who like sports, the subject must know the number of readers who like politics then the results are multiplied by two. In Figure 2 it can be seen that the subject is wrong in determining the number of readers who like politics so they are unable to answer questions correctly.

Look and learn
Figure 2 shows the subject 2 concludes the answer that has been obtained from the calculation, but the answer was incorrect. The subject has difficulty in reviewing the answer. The interview results showed that the subject was unable to explain in detail the stages of solving the problem that had been done.

Based on the results of the study, it can be seen that the subject in verbal style verbal style is able to understand the problem of HOTS using logical words which in the research problem HOTS is interpreted as a realistic problem in mathematics. The subject is still having difficulty understanding the diagram to continue the problem solving steps. This is in line with KocJanuchta's statement that students with a verbalizer cognitive style tend to be more understanding by examining text and entering non-informative areas [19]. The subject had difficulty in expressing the mathematical model of the problem given. The subject is able to understand the sentence well but is constrained by understanding the concept of a set that is still wrong. The difficulty of the concept is the obstacles experienced by students in mastering the subject matter related to abstract ideas to solve problems [20].

4. Conclusion
Based on the data analysis conducted by researchers about the difficulties of students in solving HOTS problems for mathematics, it can be concluded that students with cognitive verbal styles showed that subjects were able to understand what was known in HOTS problems. Students with verbalizer cognitive style have difficulty expressing problems in mathematical models. Students with a cognitive style verbalizer begin to have difficulty at the stage of defining goals by expressing problems in a diagram, where diagrams can help solving the problems.

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